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TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1883.

No. 282.

ALEXANDER COCHRANE, HUGH COCHRANE, AND CARL RUMPFF, APPELLANTS,

vs.

BADISCHE ANILIN AND SODA FABRIK.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

FILED AUGUST 29, 1881.

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1 The President of the United States of America to A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer, & Carl Rumpff, greeting:

You are hereby commanded, that you and each of you personally appear before the judges of the Circuit Court of the United States for the southern district of New York, in the second circuit, in equity, on the 1st Monday of May, A. D. 1875, wherever the said court shall then be, to answer a bill of complaint exhibited against you in the said court by Badische Anilin and Soda Fabrik, a corporation organized under the laws of the Grand Duchy of Baden, in the empire of Germany, and doing business at Manheim and Ludwigshafen, in said empire of Germany, and to do further and receive what the said court shall have considered in that behalf. And this you are not to omit under the penalty on you and each of you of two hundred and fifty dollars.

Witness, Hon. Morrison R. Waite, chief justice of the Supreme Court of the United States, at the city of New York, on the 5th day of April, in the year one thousand eight hundred seventy-five, and of the Independence of the United States of America the ninety-ninth.

KENNETH G. WHITE, *Clerk.*

J. VAN SANTVOORD,
& FRANCIS FORBES,
Compl'ts' Sol'rs.

The defendants are required to enter appearance in the above cause in the clerk's office of this court on or before the 1st Monday of May, 1875, or the bill will be taken *pro confesso* against them.

[L. S.] K. G. W., *Clerk.*

2 SOUTHERN DISTRICT OF NEW YORK.

William T. Smith, being duly sworn, deposeth and saith that he served the within writ of subpœna ad-respondendum upon the within named defendants, A. Cochrane, A. C. L. O. Meyer, & Carl Rumpff, at their place of business, No. 42 Beaver st., in the city of New York, on Thursday, April 8th, 1875, by leaving copies of said *said* subpœna with said defendants, at the same time showing them the original.

WM. T. SMITH.

Sworn to before me this 8th day of April, A. D. 1875.

JOHN A. SHIELDS,
U. S. Com'r S. D. of N. Y.

I hereby depute W. T. Smith to execute the within writ.

OLIVER FISKE,
U. S. Marshal.

April 5, 1874.

I certify that the within subpœna was served as appears by affidavit of W. T. Smith endorsed hereon.

OLIVER FISKE,
U. S. Marshal.

356.

Filed May 11, 1875.

3 In the Circuit Court of the United States, southern district of New York.—In equity.

To the honorable the judges of the Circuit Court of the United States for the southern district of New York:

"Badische Anilin and Soda Fabrik," a corporation organized under the laws of the Grand Duchy of Baden, in the Empire of Germany, and doing business at Manheim and Ludwigshafen, in said Empire of Germany, bring this their bill of complaint against "A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer and Carl Rumpff," defendants, doing business at Boston, Massachusetts, in the district of Massachusetts, and at the city of New York, in the state of New York, in the said southern district of New York, under the firm name or style of A. Cochrane and Co., said A. Cochrane and Hugh Cochrane residing in Massachusetts, the said Meyer residing in New Jersey, and the said Rumpff residing in Europe.

And thereupon your orators, upon information and belief, complain and say that heretofore and before the fifth day of October, 1869, Charles Graebe, of Frankfort-on-the-Main, being then a citizen of the United States, and Charles Liebermann, of Berlin, Prussia, being then a citizen of Prussia, were jointly the first and original inventors and discoverers of a certain new and useful improvement entitled Process of Preparing Alizarine, described in the letters patent dated October 5th, 1869, hereinafter mentioned, and which was not known or used by others prior to their invention thereof, and which was not and had not
4 been at the time of their application for letters patent therefor, as hereinafter mentioned, in public use or on sale with their consent and allowance, contrary to the provisions of the statutes of the United States in such case made and provided.

That they being so, as aforesaid, the first and original inventors and discoverers of the said improvement, and being a citizen of the United States, and being desirous to obtain an exclusive property in said invention or improvement within and for the United States, did on the fifth day of October, 1869, upon due application therefor, and having in all things complied with the conditions and requirements of the acts of Congress in such case made and provided, obtain letters patent of the United States for said invention or improvement in due form of law, under seal of the patent office of the United States, signed by the secretary of the interior, and countersigned by the commissioner of patents, bearing date the said fifth day of October, 1869, and numbered 95465, which said letters patent are now remaining of record in the patent office of the United States, by

which said letters patent there was granted and secured or intended to be granted and secured to them, their executors, administrators or assigns, for the term of seventeen years from the said fifth day of October, 1869, the full and exclusive right and liberty of making, using, and vending to others to be used the said invention or improvement described in said letters patent; and by virtue thereof they became and were the sole owners of all the rights and privileges granted and secured or intended to be granted and secured in and by said letters patent.

And your orators further show unto your honors that the said Charles Graebe and Charles Liebermann, having for good and lawful cause, after the issuing of the said letters patent as aforesaid, surrendered the same to the commissioner of patents, and having made due application therefor, and having in all things complied with the requirements and conditions of the acts of Congress in such case made and provided, did on the fourth day of April, 1871, obtain new letters patent, numbered 4321 of reissued letters patent, for a distinct and separate part of the same invention, on a corrected specification, for the residue of the said term of seventeen years from the fifth day of October, 1869, which said reissued letters patent were issued in due form of law, under the seal of the patent office of the United States, signed by the acting secretary of the interior, and countersigned by the commissioner of patents, bearing date the said fourth day of April, 1871, and numbered 4,321 of reissued letters patent, and which said reissued letters patent 4,321 are now remaining of record in the patent office of the United States, as by said letters patent 4,321 or a duly authenticated copy thereof, in court ready to be produced, will fully and at large appear.

And your orators further show unto your honors that afterwards, and on or about the first day of March, 1872, the said Charles Graebe and Charles Liebermann did, by an assignment in writing, duly signed, executed and delivered, and bearing date the first day of March, 1872, sell, assign and transfer unto your orators, along with other things, all their, the said Graebe and Liebermann's, rights, title and interest in and to said letters patent reissue No. 4,321, so as aforesaid granted to them, and in the invention described therein, and secured or intended to be secured thereby, which said assignment was duly recorded in the patent office of the United States on the 28th day March, 1872, in liber I[15] of transfers of patents, page 260, as by said assignment or a duly authenticated copy thereof, together with the certificate of the recording thereof, here in court ready to be produced, will fully and at large appear, and by virtue of which assignment your orators became and now are the sole owners of all the rights and privileges granted and secured, or intended to be granted and secured, in and by said letters patent, so granted as aforesaid on the said fourth day of April, 1871.

And your orators further show that, by reason of the premises, your orators have been ever since the said first day of March, 1872,

and are exclusively entitled to use, exercise and enjoy all the exclusive rights, privileges, profits and advantages granted and secured, or intended to be granted and secured, in and by said reissued
6 letters patent 4,321 for and during the term of years in said reissued letters patent mentioned.

And your orators further show unto your honors that the said invention or discovery, so patented as aforesaid, and assigned unto your orators, is very valuable and useful to the public, and that the same has been extensively introduced into public use, and that the public have generally acquiesced in your orators' exclusive right to the same; and your orators would, but for the wrongful acts of the said defendants, and others acting in concert with them, have made large gains and profits from the manufacture, use and sale of the said invention, which they have been and are now hindered from making by reason of said wrongful acts of the said defendants.

And your orators further show unto your honors, upon information and belief, that the said defendants, A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer and Carl Rumpff, well knowing the premises and the rights and privileges secured unto your orators, and in order to deprive them of the profits, benefits and advantages which might and otherwise would have accrued to them at the city of Boston aforesaid and elsewhere, and within the said district of Massachusetts, and without the license or permission of your orators, have since the first day of March, 1872, and at divers times since that time and before the commencement of this suit, unlawfully and wrongly made or caused to be made, sold or caused to be sold, used or caused to be used, said invention and dyes or coloring matter, containing the said invention or discovery and improvements, or substantial or material parts thereof, described and patented in the said reissued letters patent No. 4,321, the exclusive right to which is secured to your orators as hereinbefore set forth, and which said unlawful making, use and sale by the defendants as aforesaid are a violation and infringement of your orators' exclusive rights and privileges under the reissued letters patent as aforesaid; and that the defendants still continue so to do, in defiance of your orators' said rights and privileges, and to your orators' great and irreparable loss and injury, and by which your orators have sustained and
7 been put to great loss and damage, and have been and still are deprived of great gains and profits, which your orators might and otherwise would have obtained and received, but which have been received and enjoyed and are being received and enjoyed by the said defendants, by and through their aforesaid unlawful acts and doings; and that the said defendants have derived and received and are still deriving and receiving from such use great gains and profits, but to what amount your orators are ignorant and cannot set forth, but your orators believe the same to be about the full sum of twenty thousand dollars, and so charge the fact to be, and pray that the said defendants may be required to make a discovery as to their

use of said invention, and of all gains and profits received by them therefrom or by means thereof.

And your orators further show unto your honors that the aforesaid using of said invention by the said defendants and their confederates, and their preparation and determination to continue the same, and the aforesaid unlawful and wrongful acts, have the effect to encourage and induce other persons to infringe and defy the letters patent as aforesaid and the aforesaid exclusive rights and privileges of your orators.

And your orators further show unto your honors that the said defendants have been warned and requested and notified to desist and refrain from said infringement and said unlawful and wrongful acts, but that said warning and request and notice have been wholly disregarded by said defendants, and that said defendants still continue the infringement and unlawful and wrongful acts aforesaid.

And your orators pray that the said defendants may be compelled, by a decree of this honorable court, to account for and pay over unto your orators all such gains and profits as have accrued or arisen to or have been earned or received by the said defendants, and all damages your orators have sustained by reason of the said infringements by the said defendants.

And that the said defendants, A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer and Carl Rumpff, their agents, attorneys, servants and workmen, be enjoined and restrained by the order and injunction of this court from directly or indirectly making or causing to be made, using or causing to be used, or vending to others to be used, said inventions in any manner, or any dyes or coloring matter containing or embodying or in any way counterfeiting or imitating the said invention described and secured in said reissued letters patent so granted as aforesaid, and from infringing upon or violating the said letters patent by the use or sale of the said invention of said dyes or coloring matter in any way whatever; and that all such infringing dyes or coloring matter in the possession of said defendants may be forthwith destroyed or delivered up to your orators; and that the said defendants may be decreed to pay the costs of this suit; and that your orators may have such other or further order or relief as to this honorable court shall seem meet and shall be agreeable to equity.

8

To the end, therefore, that the said defendants, A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer and Carl Rumpff, may, if they can, show why your orators should not have the relief hereby prayed, and may, upon their several corporal oaths, true and direct and perfect answer make, according to the best of their, or their agents, clerks, servants and workmen's knowledge, remembrance, information and belief, to the several matters hereinbefore averred and set forth as fully and particularly as if the same were here repeated paragraph by paragraph, and they thereto severally and specifically interrogated.

May it please your honors to grant to your orators a writ of *sub-*

pœna ad respondendum, issuing out of and under the seal of this honorable court, directed to the said defendants, A. Cochrane, Hugh Cochrane, A. C. L. O. Meyer and Carl Rumpff, commanding them and each of them by a certain day, and under a certain penalty, to be and appear in this honorable court, then and there to make answer unto this bill of complaint, and to perform and abide by such order and decree herein as to this court may seem meet and agreeable to equity.

And your orators will ever pray, &c.

BADISCHE ANILIN AND SODA FABRIK,
By ADOLF KUTTROFF, *Attorney.*

J. VAN SANTVOORD and FRANCIS FORBES,
Complainants' Solicitors.

GEORGE GIFFORD, *of Counsel.*

UNITED STATES OF AMERICA,
9 *City and county of New York,* } *ss.*
Southern district of New York,

ADOLF KUTTROFF, the attorney in fact of the complainants in the foregoing complaint named, being duly sworn, deposes and says that he has read the foregoing bill of complaint by him subscribed, and knows the contents thereof, and that the same are true of his own knowledge, except as to those matters therein stated on information and belief, and as to those matters he believes it to be true. And he further deposes and says that he verily believes that the said Charles Graebe and Charles Liebermann, the first and original inventors or discoverers of the invention or improvement patented to them, as set forth in said bill of complaint, and that the same has not, to the best of his knowledge, information, and belief, been in use or been described before the invention thereof by said Graebe and Liebermann; and deponent further says that his information is derived in part from his correspondence with the said complainants, who carry on business in Germany, and from his own business transactions and those of his firm, Wm. Pickhardt and Kuttroff, of said city of New York, with complainants; and deponent further says that he has been appointed and now is the true and lawful attorney of complainants, with power to sue persons infringing said reissued letters patent in said bill mentioned.

ADOLF KUTTROFF.

Subscribed and sworn to before me this 5 day of April, 1875.

R. E. STILLWELL,
U. S. Com'r.

United States Circuit Court, southern district of New York, in equity.

BADISCHE ANILIN & SODA FABRIK
agst.
A. COCHRANE, HUGH COCHRANE, A. C. L. O. MEYER, & CARL RUMPFF.

SIR: Please enter our appearance as solicitors in the above-entitled action for the defendants, A. Cochrane, A. C. L. O. Meyer, and Carl Rumpff. Dated New York, May 3, 1875.

Yours, etc.,

DICKERSON & BEAMAN,
Def'ts Sol'rs.

To the clerk Circuit Court United States, district of New York. Filed May 3d, 1875.

10 In the Circuit Court of the United States for the southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE, A. C. L. O. MEYER, and CARL RUMPFF. } In Equity.

The joint and several answers of A. Cochrane, Hugh Cochrane, (who are partners under the name of Cochrane & Co.,) and Carl Rumpff to the bill of complaint of Badische Anilin and Soda Fabrik, complainants.

These defendants, now and at all times hereafter saving and reserving unto themselves all benefit and advantage of exception which can or may be had or taken to the many errors, uncertainties, and other imperfections in the said complainants' said bill of complaint contained, for answer thereto, or unto so much and such parts thereof as these defendants are advised is or are material or necessary for them to make answer unto, these defendants for answering say:

First. They have no knowledge, other than that derived from the bill of complaint, whether the Badische Anilin and Soda Fabrik is a corporation organized under the laws of the Grand Duchy of Baden, in the Empire of Germany, and they therefore deny the same, and leave the complainants to make such proof thereof as they may be advised.

Second. And these defendants, in further answering, say that they have not manufactured or caused to be manufactured any alizarine at the city of Boston or elsewhere within the district of Massachusetts, or within the United States, as is charged in the bill of complaint herein, according to the process described in the said letters patent, or otherwise.

11 Third. And these defendants, in further answering, say that they have sold or caused to be sold alizarine in the United States which, as they are informed and believe, was lawfully manufactured in Germany, and which was imported into the United States as an article of commerce.

Fourth. And these defendants, in further answering, say that the alizarine sold by them as aforesaid was not manufactured by the process described in the said reissued letters patent No. 4,321 or by any process substantially the same, but that the same was manufactured according to processes which were invented subsequent to the date of the said original letters patent, and which are the subject of different and independent letters patent.

Fifth. And these defendants, in further answering, say that alizarine is a natural product having a well-known definite constitution, and that it is not a composition of matter within the meaning of the statute, but has been well known in the arts from time immemorial for the purpose of dyeing, and that it has generally been extracted from "madder-root" and from other analogous products by various processes suitable for that purpose. These defendants therefore say that there can be no valid patent granted for alizarine, and that the said reissued letters patent are void. And these defendants refer to *Watts' Chemical Directory*, published before 1869, under the title *Alizarine*, to show that alizarine was well known long before the said patent.

Sixth. And these defendants, in further answering, say that the said reissued letters patent are void, because the claim thereof is for more than the invention of the patentee, as the same appears in the description of the invention in said letters patent.

And these defendants deny all and all manner of unlawful combination and confederacy wherewith they are by the said bill charged, without this, that there is any other matter, cause or thing in the said complainants' said bill of complaint contained material or necessary for these defendants to make answer unto and not herein and hereby well and sufficiently answered, confessed, traversed and avoided

12 or denied, is true to the knowledge or belief of these defendants; all which matters and things these defendants are ready and willing to aver, maintain and prove as this honorable court shall direct, and humbly pray to be hence dismissed with their reasonable costs and charges in this behalf wrongfully sustained.

DICKERSON & BEAMAN,
Sol'rs for Def'ts and of Counsel.

UNITED STATES OF AMERICA,
Southern district of New York, } ss.

CARL RUMPFF, being duly sworn, deposes and says that he is one of the defendants named in the foregoing answer; that he has read the same and knows the contents thereof; and that the same is true of his own knowledge, except as to the matters therein stated on in-

formation and belief, and as to those matters he verily believes it to be true.

CARL RUMPFF.

Sworn to before me this 5th day of June, 1875.

JOHN A. SHIELDS,
U. S. Com'r.

UNITED STATES OF AMERICA,
Southern district of New York, } *ss.*

ALEXANDER COCHRANE, one of the defendants above named, being duly sworn, deposes and says: I am a partner in the firm of A. Cochrane & Co., and a defendant in the above suit. I have read the foregoing answer and know the contents thereof; and the same is true of my own knowledge, except as to the matters therein stated on information and belief, and as to those matters I believe it to be true.

ALEXANDER COCHRANE.

Sworn to before me this 5th day of June, A. D. 1875.

JOHN A. SHIELDS,
U. S. Com'r.

(Endorsed:) U. S. Circuit Court, southern district of New York; Badische Aniline & Soda Fabrik *vs.* A. Cochrane & others; answer of A. Cochrane & Carl Rumpff; Dickerson & Beaman, solicitors & of counsel for def'ts; filed June 14, 1875.

13 United States Circuit Court, southern district of New York.

THE BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, A. C. L. O. MEYER and CARL RUMPFF. } In Equity.

The replication of the Badische Anilin and Soda Fabrik, complainants, to the answer of A. Cochrane, Hugh Cochrane and Carl Rumpff, defendants.

These repliants, saving and reserving to themselves now and at all times hereafter all and all manner of benefit and advantage of exception which may be had or taken to the manifold insufficiencies of the said answer, for replication thereunto say that they will aver,
maintain and prove their said bill of complaint to be true,
14 certain and sufficient in law to be answered unto, and that the
said answer of the said defendants is uncertain, untrue and insufficient to be replied unto by these repliants.

Without this, that any other matter or thing whatsoever in the said answer contained material or effectual in the law to be replied unto, and not herein and hereby well and sufficiently replied unto, confessed or avoided, traversed or denied, is true.

All which matters and things these repliants are and will be ready

to aver, maintain and prove as this honorable court shall direct, and humbly pray as in and by their said bill they have already prayed.

J. VAN SANTVOORD and
FRANCIS FORBES,
Complainants' Solicitors.

15 GEORGE GIFFORD, ESQ., *of Counsel.*

(Endorsed:) Circuit Court U. S., south dist. of N. Y.; Badische Anilin Soda Fabrik *vs.* A. Cochrane, Hugh Cochrane, Carl Rumpff, A. C. L. O. Meyer; replication to answer of A. Cochrane, Hugh Cochrane and Carl Rumpff. Van Santvoord and Forbes, complainants' solicitors; filed June 26, 1875.

16 Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE, A. C. L. O. MEYER and CARL RUMPFF. } In Equity.

Upon reading and filing the stipulation and consent hereunto annexed, signed by the solicitors for the respective parties, on motion of Van Santvoord & Forbes, solicitors for the complainants, it is hereby ordered that the above-entitled action be discontinued as to the defendant A. C. L. O. Meyer, without costs to any of the parties to said action and without prejudice to the remaining parties therein.

SAMUEL BLATCHFORD.

Dated August 5th, 1875.

Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE, A. C. L. O. MEYER and CARL RUMPFF. } In Equity.

It is hereby stipulated and consented that the above-entitled action be discontinued as to the said defendant A. C. L. O. Meyer, without costs to either party and without prejudice to the remaining parties therein, and that this honorable court is hereby requested to order accordingly.

VAN SANTVOORD & FORBES,
Complainants' Solicitors.
DICKERSON & BEAMAN,
Defendants' Solicitors.

New York, July 14, 1875.

17 Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE and CARL RUMPFF. } In Equity.

Upon reading and filing the annexed stipulation, on motion of Van Santvoord & Forbes, complainants' solicitors, it is hereby ordered that John G. Stetson, esq., of Boston, Massachusetts, be and he is hereby appointed special examiner herein under the 67th rule of the Supreme Court in equity, as amended, to take the depositions of witnesses residing in the district of Massachusetts, both on the part of the complainants and of the defendants.

SAMUEL BLATCHFORD.

August 5th, 1875.

Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE and CARL RUMPFF. } In Equity.

It is hereby stipulated and agreed that John G. Stetson, of Boston, Massachusetts, be appointed special examiner herein, under the 67th rule of the Supreme Court in equity, as amended, to take depositions of witnesses residing in the district of Massachusetts, both on the part of the complainants and the defendants.

VAN SANTVOORD & FORBES,
Complainants' Solicitors.
DICKERSON & BEAMAN,
Defendants' Solicitors.

New York, July 23, 1875.

18 *Complainant's Exhibit A.*

October 19, 1875; R. E. S., examiner.

The United States Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy, from the records of this office, of the reissued letters patent granted Graebe and Liebermann, dated April 4, 1871, No. 4,321, for "Improvement in Dyes or Coloring Matter from Anthracine."

In testimony whereof, I, Ellis Spear, acting commissioner of patents, have caused the seal of the patent office to be hereunto affixed this fifteenth day of May, in the year of our Lord one thousand eight

hundred and seventy-five, and of the Independence of the United States the ninety-ninth.

[L. S.] ELLIS SPEAR,
Acting Commissioner.

No. 4,321. Reissue.

The United States of America.

To all to whom these letters patent shall come:

Whereas Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia, have alleged that they have invented a new and useful improvement in dyes or coloring matter from anthracine (for which letters patent were issued to them, dated October 5, 1869, which letters have been surrendered, the same having been cancelled, and new letters ordered to issue to them on two separate amended specifications), and have made oath, the said Graebe that he is a citizen of the United States, and the said Liebermann that he is a citizen of the Kingdom of Prussia, that they verily believe they are the original and first inventors or discoverers of the said improvement, and that the same hath not to their knowledge and belief been previously known or used, have paid into the treasury of the United States the sum of thirty dollars, and presented a petition to the commissioner of patents praying that a patent may be issued therefor—

19 These are, therefore, to grant to the said Graebe and Liebermann, their executors, administrators, or assigns, for the term of seventeen years from the fifth day of October, one thousand eight hundred and sixty-nine, the full and exclusive right and liberty of making, using, and vending to others to be used the said improvement, a description whereof is given in the annexed schedule and made a part of these presents.

In testimony whereof, I have caused these letters to be made patent and the seal of the patent office to be hereunto affixed.

Given under my hand at the city of Washington, this fourth day of April, in the year of our Lord one thousand eight hundred and seventy-one, and of the Independence of the United States of America the ninety-fifth.

WALTER H. SMITH,
Acting Secretary of the Interior.

M. D. LEGGETT,
[L. S.] *Commissioner of Patents.*

Countersigned and sealed with the seal of the patent office.

United States Patent Office.

Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia.

Improvement in dyes or coloring matter from anthracine.

Specification forming part of letters patent No. 95,465, dated October 5, 1869; reissue No. 4,321, dated April 4, 1871.

Division B.

To all whom it may concern:

Be it known that we, Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, in the kingdom of Prussia, have invented a new and useful improvement in the manufacture of alizarine; and we do hereby declare the following to be a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same.

We first charge the anthracine into anthrakinon (oxanthracine), a substance known to the chemists by the investigations of Anderson. For this purpose we take one part, by weight, of anthracine, two and half parts, by weight, of bichromate of potash, and ten or fifteen parts, by weight, of concentrated acetic acid, and we heat these substances together in a vessel, either of glass or clay, to about 100° centigrade to 120° centigrade, till nearly all of the bichromate of potash is dissolved and the liquid has acquired a deep green color. We then recover the acetic acid not consumed in the reaction by distillation, and treat the residuum with water to remove the chromic acetate. From the insoluble mass we obtain the anthrakinon in a pure state by distilling the whole from a retort of glass or iron.

In the place of acetic acid, sulphuric acid, diluted with one or two parts of water, may be employed.

Instead of the method just described, we also employ the following one: We heat anthracine in a vessel of glass or of clay, with ten parts of concentrated acetic acid, to about 100° centigrade, or a little higher, and we add nitric acid of about 1.3 specific gravity, in small portions, till the violent reaction ceases. After distillation of the acetic acid we purify the residuum, as before. We then convert the anthrakinon, prepared by one of the methods described, into bichromanthrakinon. For this purpose we take three parts of anthrakinon, five parts of bromine, and we heat these substances for ten or twelve hours, or until nearly the whole of the bromine has disappeared, to a temperature, by preference, of about 100° centigrade, in a suitable close vessel, either of glass or enameled or glazed iron, which is capable of sustaining the pressure which is generated by the reaction. The apparatus is then allowed to cool. It is opened in order to permit the escape of bromic acid, which can be recovered by absorption either in water or in alkaline solution.

We purify the bibromanthrakinon remaining in the vessel, as a solid substance, by crystallization from benzole.

Instead of the method above described for preparing bibromanthrakinon, we also employ the following: We convert, first, the
21 anthracine into a bromine derivative, into the tetrabromanthracine, known to chemists by the investigations of Anderson. We take one part of this tetrabromanthracine and we heat it in a retort of glass or clay with about five parts of nitric acid, of about 1.3 specific gravity, to 100° centigrade, as long as vapors of bromine are evolved. We distill off the greater portion of the nitric acid, wash the residuum with water, and purify it by crystallization from benzole. We thus receive the bibromanthrakinon, as before, in a yellow solid mass. We then convert the bibromanthrakinon into alizarine. For this purpose we take one part of bibromanthrakinon, two or three parts of caustic potash or soda, and so much water as is necessary to dissolve the alkali, and we heat the same in an open vessel of glass, glazed or enameled iron or silver, to about 180° to 260° centigrade, for one hour or till the mass has acquired a deep blue color. We then dissolve it in water, and filter the violet solution, from which we precipitate the alizarine by inorganic acid. We collect the yellow flocks of alizarine thus obtained on a filter and wash them with water.

By these methods we receive the alizarine in a form in which it can be employed in the same manner as the different preparations from madder.

In the place of bromine, chlorine, also, may be employed, but not so conveniently, as the reactions above described are more difficult to accomplish with chlorine than with bromine.

What we claim as new and desire to secure by letters patent, is—

Artificial alazarine produced from anthracine or its derivatives by either of the methods herein described, or by any other method which will produce a like result.

This specification signed by us this 30th day of November, 1870.

CHARLES GRAEBE.
CHARLES LIEBERMANN.

Witnesses as to the signature of Charles Liebermann:
H. KREISMANN.
G. MAUFE.

Witnesses:
OTTO PETZEKE.
ROBT. PRENDS.

22 *Complainants' Exhibit B.*

October 19, 1875.
R. E. S.,
Examiner.

The U. S. Patent Office.

To all persons to whom these presents shall come, greeting:

This to certify that the annexed is a true copy from the records of this office.

In testimony whereof, I, Ellis Spear, acting commissioner of patents, have caused the seal of the patent office to be hereunto affixed this fifteenth day of May, in the year of our Lord one thousand eight hundred and seventy-five, and of the independence of the United States the ninety-ninth.

ELLIS SPEAR,
Acting Commissioner.

(Liber I[15], p. 260.) Assignment.

Whereas, we, Charles Graebe of Frankfort-on-the-Main, and Charles Liebermann of Berlin, Prussia, did obtain letters patent of the United States of America for certain improvements in process of preparing alizarine, which letters patent bear date the fifth day of October, eighteen hundred and sixty-nine, and are numbered 95,465, which letters patent were surrendered, and new letters patent were obtained by us for the same invention in two divisions, dated April 4, 1871, and numbered 4,320 and 4,321 respectively;

And whereas Badische Anilin and Soda Fabrik, in Ludwigshafen, a corporation organized under the laws of the Grand Duchy of Baden, German Empire, is desirous of acquiring an interest therein:

Now, this indenture witnesseth, that for and in consideration of the sum of five dollars, to us, the said Charles Graebe and Charles Liebermann, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold and set over, and do hereby assign, sell and set over unto the said Badische Anilin and Soda Fabrik, in Ludwigshafen, its successors and assigns, all the right, title
23 and interest we have in the said invention, as secured to us by said reissued letters patent:

The same to be held and enjoyed by the said Badische Anilin and Soda Fabrik, in Ludwigshafen, for its own use and behoof, and for the use and behoof of its legal representatives, to the full end of the term for which said letters patent are granted, as fully and entirely as the same would have been held and enjoyed by us if this assignment and sale had not been made.

In testimony whereof we hereunto set our hands and affix our seals this first day of March, eighteen hundred and seventy two.

March 1st, 1872. 5.

CHARLES GRAEBE. [L. S.]
CHARLES LIEBERMANN. [L. S.]

Sealed and delivered in presence of—
Dr. C. A. KNOYE, Merlin, *Mittesetr*, 42.

Recorded March 28, 1872. J. A. W., *Ex.*

Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE et al.

EVIDENCE FOR COMPLAINANTS.

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States, in equity, as amended.
Before me, JOHN G. STETSON,
Examiner.

24 BOSTON, *August 13th*, 1875.

Present—John Van Santvoord, esq., of counsel for complainants; Edward N. Dickerson, esq., of counsel for defendants.
Before me, JOHN G. STETSON, *Examiner.*

Deposition of William K. Browne.

Direct examination by John Van Santvoord, esq., of counsel for complainants:

BOSTON, *August 13th*, 1875.

Question 1. Please state your name, age, residence, and occupation.

Answer. William K. Browne; 34; Boston, Mass.; agent for William Pickhardt & Kuttroff, importers and dealers in dye stuffs and chemicals.

Q. 2. Did you obtain from the Hamilton Manufacturing Company of Lowell, Massachusetts, any sample of artificial alizarine; and if so, state from whom you obtained the same, and in what package or packages they were given you, and the time you obtained them?

A. I did, from James Harley, assistant superintendent of the Hamilton Manufacturing Company. They were given to me in two bottles, I holding the bottles; and Mr. James Harley poured the contents, artificial alizarine, from a keg into them. These samples were obtained March 23d, 1875.

Q. 4. Did you understand at the time, from Mr. Harley or from any other person connected with the said Hamilton Manufacturing Company, from whom they bought said artificial alizarine?

A. I did understand that the keg of artificial alizarine was bought by Mr. Dupee, treasurer, from A. Cochrane & Company, through information received from both the superintendent and assistant superintendent.

Q. 4. State whether or not you enclosed the contents of said bottles and marked them in any way; and if so, state how.

A. I did. I placed the glass stopper in each of the bottles
25 and secured it by covering it with kid. Placed also labels upon each of the bottles, and in my own handwriting wrote upon the same, first, on one bottle, A. Cochrane & Co., alizarine from Hamilton, Lowell, March 23d, 1875; second, on the other bottle, A. Cochrane & Co., from Hamilton Pt. Wks., Lowell, alizarine, Mch. 23d, '75.

Q. 5. What did you do with those bottles and contents?

A. I sent one bottle by express to William Pickhardt & Kuttroff, on March 23, 1875, to No. 23 Cedar street, New York. The other bottle I retained in my possession until to-day.

Q. 6. Please produce the bottle and contents retained in your possession.

A. I do.

(Counsel for complainant offers the above in evidence, and the same is marked "Artificial Alizarine, Exhibit Browne No. 1."—J. G. S., examiner.)

Q. 7. Look at the bottle and contents I now show you and state if that is, to the best of your knowledge and belief, what you sent by express to Messrs. Pickhardt & Kuttroff, as you have stated.

A. It is.

(Counsel for complainants offers the above in evidence, and the same is marked "Artificial Alizarine, Exhibit Browne No. 2."—J. G. S., examiner.)

WILLIAM K. BROWNE.

Deposition of James A. Dupee.

Direct examination by John Van Santvoord, esq., of counsel for complainants:

Question 1. Please state your name, age, residence, and occupation.

Answer. James A. Dupee; 56; Winchester, Massachusetts; treasurer of the Hamilton Manufacturing Company of Lowell, Massachusetts.

Q. 2. State whether or not you, as treasurer of said company, ever bought any artificial alizarine of the defendants; and if so, how much and when.

A. I did buy, February 8th, 1875, fifty-five pounds of artificial alizarine of A. Cochrane & Company.

26 Q. Did you receive a bill and receipt therefor; and if so, will you please produce it?

A. I did, sir; and there it is.

(Counsel for complainants offers the above in evidence, and the same is marked Exhibit Dupee.—J. G. S., examiner.)

(It is agreed by counsel that a copy of the above shall be placed in evidence with the same force and effect as the original.)

Q. 4. State whether the artificial alizarine you so bought was de-

Sealed and delivered in presence of—
Dr. C. A. KNOYE, Merlin, *Mittesetr*, 42.

Recorded March 28, 1872. J. A. W., *Ex.*

Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE et al.

EVIDENCE FOR COMPLAINANTS.

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States, in equity, as amended.
Before me, JOHN G. STETSON,
Examiner.

24 BOSTON, *August 13th*, 1875.

Present—John Van Santvoord, esq., of counsel for complainants; Edward N. Dickerson, esq., of counsel for defendants.
Before me, JOHN G. STETSON, *Examiner.*

Deposition of William K. Browne.

Direct examination by John Van Santvoord, esq., of counsel for complainants:

BOSTON, *August 13th*, 1875.

Question 1. Please state your name, age, residence, and occupation.

Answer. William K. Browne; 34; Boston, Mass.; agent for William Pickhardt & Kuttroff, importers and dealers in dye stuffs and chemicals.

Q. 2. Did you obtain from the Hamilton Manufacturing Company of Lowell, Massachusetts, any sample of artificial alizarine; and if so, state from whom you obtained the same, and in what package or packages they were given you, and the time you obtained them?

A. I did, from James Harley, assistant superintendent of the Hamilton Manufacturing Company. They were given to me in two bottles, I holding the bottles; and Mr. James Harley poured the contents, artificial alizarine, from a keg into them. These samples were obtained March 23d, 1875.

Q. 4. Did you understand at the time, from Mr. Harley or from any other person connected with the said Hamilton Manufacturing Company, from whom they bought said artificial alizarine?

A. I did understand that the keg of artificial alizarine was bought by Mr. Dupee, treasurer, from A. Cochrane & Company, through information received from both the superintendent and assistant superintendent.

Q. 4. State whether or not you enclosed the contents of said bottles and marked them in any way; and if so, state how.

A. I did. I placed the glass stopper in each of the bottles
25 and secured it by covering it with kid. Placed also labels upon each of the bottles, and in my own handwriting wrote upon the same, first, on one bottle, A. Cochrane & Co., alizarine from Hamilton, Lowell, March 23d, 1875; second, on the other bottle, A. Cochrane & Co., from Hamilton Pt. Wks., Lowell, alizarine, Mch. 23d, '75.

Q. 5. What did you do with those bottles and contents?

A. I sent one bottle by express to William Pickhardt & Kuttroff, on March 23, 1875, to No. 23 Cedar street, New York. The other bottle I retained in my possession until to-day.

Q. 6. Please produce the bottle and contents retained in your possession.

A. I do.

(Counsel for complainant offers the above in evidence, and the same is marked "Artificial Alizarine, Exhibit Browne No. 1."—J. G. S., examiner.)

Q. 7. Look at the bottle and contents I now show you and state if that is, to the best of your knowledge and belief, what you sent by express to Messrs. Pickhardt & Kuttroff, as you have stated.

A. It is.

(Counsel for complainants offers the above in evidence, and the same is marked "Artificial Alizarine, Exhibit Browne No. 2."—J. G. S., examiner.)

WILLIAM K. BROWNE.

Deposition of James A. Dupee.

Direct examination by John Van Santvoord, esq., of counsel for complainants:

Question 1. Please state your name, age, residence, and occupation.

Answer. James A. Dupee; 56; Winchester, Massachusetts; treasurer of the Hamilton Manufacturing Company of Lowell, Massachusetts.

Q. 2. State whether or not you, as treasurer of said company, ever bought any artificial alizarine of the defendants; and if so, how much and when.

A. I did buy, February 8th, 1875, fifty-five pounds of artificial alizarine of A. Cochrane & Company.

26 Q. Did you receive a bill and receipt therefor; and if so, will you please produce it?

A. I did, sir; and there it is.

(Counsel for complainants offers the above in evidence, and the same is marked Exhibit Dupee.—J. G. S., examiner.)

(It is agreed by counsel that a copy of the above shall be placed in evidence with the same force and effect as the original.)

Q. 4. State whether the artificial alizarine you so bought was de-

livered at your print works, and state the source of your information.

A. It was so delivered and used as by the information of Mr. Harley, the superintendent of the print works.

Cross-examination by Edward N. Dickerson, esq., of counsel for defendants:

x 5. Did you ever see any alizarine that was not artificial; and if so, what did it look like, and how do you suppose it ever came into existence?

A. I have not.

Direct examination resumed:

Q. 6. In what sense is the word used—I mean the word "artificial"—among commercial people, as applied to alizarine?

A. As a product of anthracine, commercially speaking.

Cross-examination resumed:

x 7. As you understand the term, has it any other significance than to indicate the source from which the alizarine is produced by some chemical process?

A. Commercially, no; chemically, yes.

x 8. State what you mean by the chemical significance of the word artificial, as applied to alizarine.

A. Speaking commercially, we refer to the alizarine made from anthracine, understanding at the same time that alizarine is a most important constituent of madder.

JAS. A. DUPEE.

It is admitted by counsel for defendants that Mr. James
27 Harley, the assistant superintendent of the Hamilton Manufacturing Company, would testify, if present, that he gave to Mr. William K. Browne, complainants' witness, on the 23d day of March, 1875, the contents of the bottles marked respectively Exhibits Browne No. 1 and Browne No. 2, as stated in the deposition of the said Browne; and that the said Harley took the same from a package of artificial alizarine procured by said company from A. Cochrane & Co., of Boston, February 8th, 1875, as testified to by the witness Dupee.

(Attest:) JOHN G. STETSON,
Examiner.

(Copy.)

BOSTON, *February 8th*, 1875.

Net Cash.
Hamilton Mfg. Co.
Bought of A. Cochrane & Co.,
Manufacturers of Chemicals
and Dealers in Drugs and Dye Stuffs.
Office, 22 Broad street.
☞ Please send bill of Carboys, etc., returned,
and mark packages with our address.

ALEXANDER COCHRANE.
HUGH COCHRANE.

Copy Exhibit Dupee.
J. G. S., *examiner*.

1 Keg Alizarine, 10 per cent., No. II.
F. B. & C., Gross 69½ Tr. 14½.
3,707. Net, 55 lbs. @ 1 Gold, $55 Gold.
Paid Feb. 23, 1875.

A. COCHRANE & CO.
E. GAY.

D. B.
Ex. D. L. P.

(Endorsement:) $55.00 Gold. A. Cochrane & Co. Feby. 8, 1875.

28 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et al. } In Equity.

Please take notice that the complainants in the above cause will proceed to take testimony in the same orally, under the 67th rule in equity, as amended, before R. E. Stillwell, esq., one of the examiners of this court, on Wednesday, September 22, 1875, at eleven o'clock in the forenoon of that day, at the office of Van Santvoord & Hauff, No. 41 Park row, in the city of New York.

Dated New York, September 18, 1875.

VAN SANTVOORD & FORBES,
Compl'ts' Sol'rs.

To DICKERSON AND BEAMAN, esqrs.,
Def'ts' Sol'rs.

CITY AND COUNTY OF NEW YORK, *ss.*

ROB'T E. MILLER, being duly sworn, deposes and says that on the 18th day of September, 1875, at the office of Dickerson and Beaman,

livered at your print works, and state the source of your information.

A. It was so delivered and used as by the information of Mr. Harley, the superintendent of the print works.

Cross-examination by Edward N. Dickerson, esq., of counsel for defendants:

x 5. Did you ever see any alizarine that was not artificial; and if so, what did it look like, and how do you suppose it ever came into existence?

A. I have not.

Direct examination resumed:

Q. 6. In what sense is the word used—I mean the word "artificial"—among commercial people, as applied to alizarine?

A. As a product of anthracine, commercially speaking.

Cross-examination resumed:

x 7. As you understand the term, has it any other significance than to indicate the source from which the alizarine is produced by some chemical process?

A. Commercially, no; chemically, yes.

x 8. State what you mean by the chemical significance of the word artificial, as applied to alizarine.

A. Speaking commercially, we refer to the alizarine made from anthracine, understanding at the same time that alizarine is a most important constituent of madder.

JAS. A. DUPEE.

It is admitted by counsel for defendants that Mr. James
27 Harley, the assistant superintendent of the Hamilton Manufacturing Company, would testify, if present, that he gave to Mr. William K. Browne, complainants' witness, on the 23d day of March, 1875, the contents of the bottles marked respectively Exhibits Browne No. 1 and Browne No. 2, as stated in the deposition of the said Browne; and that the said Harley took the same from a package of artificial alizarine procured by said company from A. Cochrane & Co., of Boston, February 8th, 1875, as testified to by the witness Dupee.

(Attest:) JOHN G. STETSON,
Examiner.

(Copy.)

BOSTON, *February 8th*, 1875.

Net Cash.
Hamilton Mfg. Co.
Bought of A. Cochrane & Co.,
Manufacturers of Chemicals
and Dealers in Drugs and Dye Stuffs.
Office, 22 Broad street.
☞ Please send bill of Carboys, etc., returned,
and mark packages with our address.

ALEXANDER COCHRANE.
HUGH COCHRANE.

Copy Exhibit Dupee.
J. G. S., *examiner*.

1 Keg Alizarine, 10 per cent., No. II.
F. B. & C., Gross 69½ Tr. 14½.
3,707. Net, 55 lbs. @ 1 Gold, $55 Gold.
Paid Feb. 23, 1875.

A. COCHRANE & CO.
E. GAY.

D. B.
Ex. D. L. P.

(Endorsement:) $55.00 Gold. A. Cochrane & Co. Feby. 8, 1875.

28 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et al.
} In Equity.

Please take notice that the complainants in the above cause will proceed to take testimony in the same orally, under the 67th rule in equity, as amended, before R. E. Stillwell, esq., one of the examiners of this court, on Wednesday, September 22, 1875, at eleven o'clock in the forenoon of that day, at the office of Van Santvoord & Hauff, No. 41 Park row, in the city of New York.

Dated New York, September 18, 1875.

VAN SANTVOORD & FORBES,
Compl'ts' Sol'rs.

To DICKERSON AND BEAMAN, esqrs.,
Def'ts' Sol'rs.

CITY AND COUNTY OF NEW YORK, *ss.*

ROB'T E. MILLER, being duly sworn, deposes and says that on the 18th day of September, 1875, at the office of Dickerson and Beaman,

he served a notice, of which within is a copy, on one of the clerks in charge of said office by delivering said notice to and leaving the same with said clerk in said office.

ROB'T E. MILLER.

Subscribed and sworn to before me this 22d day of September, A. D. 1875.

R. E. STILWELL,
U. S. Com'r.

29 Circuit Court of the United States for the southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE and CARL RUMPFF.

Testimony taken on the part of the complainants, under the 67th rule of the Supreme Court of the United States (as amended), pursuant to the annexed notice, to be used on the final hearing of this cause before the Circuit Court of the United States for the southern district of New York.

R. E. STILWELL, *Examiner.*

WEDNESDAY, *Sept.* 22d, 1875.

Present—John Van Santvoord, esq., counsel for complainants; Dickerson and Beaman, esqrs., counsel for defendants.

Adjourned to October 6, 1875, at 11 a. m.

WEDNESDAY, *Oct.* 6, 1875.

Present—counsel as before.

Adjourned to 19th inst., at 11 a. m.

NEW YORK, *Oct.* 19, 1875.

Present—counsel as before.

ADOLPH KUTTROFF, a witness for complainants, deposes and says:

Question 1. Are you one of the firm of Pickhardt & Kuttroff, merchants of this city?

Answer. I am.

Q. 2. Look at the bottle marked Exhibit Browne No. 2, and state if you ever had it in your possession; and if so, from whom did you receive it and when and what did you do with it?

A. I received this bottle March 24th, 1875. Kept it in my possession until April 5th, 1875, when I handed it to Mr. William Hauff, with a request to hand it to Professor Hedrick, at Wash-
30 ington. I reeeived it from W. K. Browne, of Boston, who sent it to us by Adams Express.

Q. 3. Was the bottle, when you had it in your possession, whole, and did it contain anything?

A. Yes, sir; the bottle was whole and contained what appeared to be artificial alizirene in liquid paste form.

Q. 4. State if you marked the bottle for identification in any way; and if so, how?

A. I marked the label on the bottle, Rec'd March 24, '75; del. to Wm. H. April 5th, '75.

ADOLF KUTTROFF.

Sworn to before me this 19th day of Oct., 1875.

JOHN A. SHIELDS,
Examiner.

WILLIAM HAUFF, being duly sworn as a witness on the part of the complainants, says:

Q. 1. Are you one of the firm of Van Santvoord & Hauff, of this city?

A. Yes.

Q. 2. Do you know Professor Hedrick, here present?

A. Yes.

Q. 3. Did you ever have in your possession the bottle Exhibit Browne No. 2; and if so, from whom did you obtain it, and when and what did you do with it?

A. I received this bottle from Mr. A. Kuttroff on the 5th day of April, 1875, and on the next day I delivered it to Professor Hedrick, in Washington.

Q. 4. Was it then in a whole condition and was anything contained therein?

A. It was whole and contained what I was told to be artificial alizarine.

Q. 5. Did you mark said bottle while it was in your possession; and if so, how?

A. I marked it with my initials, with the date when I received it. Those marks are on the label yet, at the upper right-hand corner of the smaller label.

W. HAUFF.

Subscribed and sworn to before me this 19th October, 1875.

R. E. STILWELL,
U. S. Com'r.

31 Present: Counsel as before.

Counsel for complainants puts in evidence a certified copy of letters patent of the United States, a reissue, 4,321, bearing date April 4th, 1871, granted to Charles Graebe and Charles Liebermann for an improvement in dyes or coloring matter from anthracine, and the same is marked Complainants' Exhibit A, October 19, 1875—R. E. S., examiner. Also a certified copy of an assignment of said patent by said patentees to the complainants, dated March 1st, 1872,

and recorded in the patent office March 28th, 1872, and the same is marked Exhibit B, October 19th, 1875—R. E. S., examiner.

BENJAMIN S. HEDRICK, a witness sworn and examined on the part of the complainants, deposes and says as follows:

Q. What is your name, age, residence, and occupation?

A. Benjamin S. Hedrick; age, 48 years; residence, district of Columbia; and general chemical examiner in the United States patent office.

Q. 2. How long have you been an examiner in the chemical class in the patent office?

A. Fourteen years and over.

Q. 3. What was your profession before you entered the patent office?

A. I was three years professor of chemistry in the university of North Carolina, for some time analytical chemist in the city of New York, and a professor in the Cooper institute. N. Y.

Q. 4. What, if any, other professional position do you now hold besides that in the patent office?

A. I have held for over three years the position of professor of chemistry in the medical department of Georgetown university, in the district of Columbia.

Q. 5. Have you read the letters patent, Complainants' Exhibit A, and do you understand the invention described and claimed therein?

A. I have and do.

Q. 6. Look at the bottle marked "Artificial Alizarine, Ex-
32 hibit Browne No. 2—J. G. S., examiner," and state if you ever saw it before, and if you ever had it in your possession; and if so, when?

A. This bottle was delivered to me by Mr. Wm. Hauff, of the firm of Van Santvoord & Hauff, on the 6th of April, 1875.

Q. 7. Was this bottle then in a perfect condition—unbroken—and did it contain anything?

A. It was, and duly sealed, and contained a yellow pasty liquid.

Q. 8. Did you then, when you received it or soon after, open it and take out some of its contents?

A. I did, soon after, remove a portion of the contents.

Q. 9. Will you please produce the portion of its contents which you then removed from said bottle?

A. I produce it; this bottle which I produce is a portion of what I took out of said bottle.

(Counsel for complainants offers in evidence the small bottle now produced by the witness, and it is marked Complainants' Exhibit Hedrick—R. E. S., examiner, Octo. 19, 1875.)

Q. 10. Have you examined any of the contents which you took, as you say, from the bottle Exhibit Browne No. 2, for the purpose of ascertaining what the same is; and if so, state what you found the same to be, and state also how it corresponds as to similarity or dis-

similarity, with the article described in and specified in the claim of said reissued patent, Complainants' Exhibit A ?

A. I did examine a portion of the contents and found the same to be artificial alizarine, as described in reissue No. 4,321. The said contents were similar in all respects—physically, chemically and in coloring properties—with the artificial alizarine described in the patent.

Q. 11. What can you say respecting the novelty of the artificial alizarine which is described in said patent and specified in the claim thereof ?

A. The composition of matter produced by the process is one entirely unknown to both science and the arts at the date of the invention of Graebe and Liebermann, and is so recognized by men all the world over. In its uses it has similarities to a number of other preparations or compositions of matter, especially to some of the madder preparations ; but it is so distinct from these that any
33 competent chemist or dyer can readily distinguish them. By decomposing it, elements and compounds may be obtained bearing great resemblance to the elements and compounds obtained by decomposing various organic matters, such as the different varieties of madder, the rhubarb plant and other species of plants; but as a dye stuff or coloring matter it is entirely new and is a most important improvement over the similar preparations known prior to the invention.

Q. 12. State some of the tests you applied to the contents of said bottle, Exhibit No. 2, for the purpose of ascertaining what the material was and for the purpose of comparing it with the material described and claimed in said reissued patent.

A. I first examined the appearance of the two materials in paste or semi-liquid form. I obtained the dry powder from each ; also examined the dry powder and the paste with a microscope to ascertain their minute physical structure. I subjected them then to heat, to ascertain their fusing point. Observed what products were driven off at different temperatures. I treated them with acid and alkalies, and observed the reactions with each. Treated them with various solvents, such as bisulphide of carbon, ether, chloroform, benzine and petroleum. Examined the matters dissolved out of each by these different solvents by placing them alongside each other under a microscope. All these tests showed the identity of the two compositions of matter.

Adjourned to Wednesday, the 20th October, 1875, at 11 a. m.

OCTOBER 20, 1875.

Present—Counsel as before.

The witness, B. S. Hedrick, being cross-examined by Mr. Dickerson, defendant's counsel, says :

x 13. Did you ever manufacture any alizarine by the process de-

scribed in the reissue patent No. 4,321; if so, when and where did you manufacture it and where is the product?

A. I did not.

34 x 14. Did you ever see any alazarine manufactured by that process; if so, where did you see it done, and who else was present?

A. I do not know exactly when I first saw it, but I have seen it in all its different stages at the Institute of Technology at Hoboken, New Jersey. Mr. Guyer was present.

x 15. When was that?

A. That was the first week in September last. I had previously seen samples that were said to have been made by it by Mr. Pickhardt.

x 16. Was that which was manufactured in Hoboken made according to the process described in the patent No. 4,321?

A. It was.

x 17. Have you any of that product?

A. None of the completed product.

x 18. Have you any knowledge of the process by which the sample of alizarine in the bottle marked Complainants' Exhibit Hedrick, R. E. S, examiner, Octo. 19, 1875, was made?

A. I have not, as I did not see it made.

x 19. Have you any means of ascertaining by what process it was made?

A. I have not, except by inference. It could have been made by the process described in the patent, and no doubt by other equivalent processes.

x 20. Did you mean to inform the court that in your opinion that sample was made by the use of bromine, as described in that patent?

A. I did not. Bromine, though it may be used in the preparation of the article, does not inhere in it. It fact, the patent states that other substances producing the same effect may be used.

(The last sentence of the answer objected to as irrelevant and not responsive; and the witness is instructed by Mr. Dickerson to answer the questions and not argue the case.

The witness states that the mention of the fact that bromine did not inhere in that product was given as a reason why he would

35 not be able to say whether bromine had been used or not, unless he had seen the article manufactured.)

x 21. Did you mean to say that, in your opinion, that sample of alizarine had been made by the use of either bromine or chlorine, as mentioned in the patent?

A. I did not.

x 22. Did you believe, when you gave your deposition, or do you now believe, that it had been made by the use of either?

(Objected to as irrelevant and immaterial.)

A. I meant to express no opinion as to what process actually was used in the manufacture of that particular sample. I only meant to

say that if the process described in the patent were followed it would produce just the material in that exhibit.

x 23. Question repeated.

A. I have no opinion on the subject.

x 24. Have you no belief on the subject?

A. Unless I had been present at the manufacture I could have no data for a belief.

x 25. Question repeated.

A. I have not.

x 26. Have you had no conversation with your employers on the subject of the manufacture of alazarine by them or by the defendants?

A. I had not.

x 27. Have you no information from any source from which you have formed an opinion as to the manufacture of alazarine by your employers or by the defendants?

(Objected to as irrelevant and immaterial.)

A. I have not.

x 28. Is it not your belief that the alazarine manufactured either by your employers or by the defendants is manufactured without the use of either bromine or chlorine, as described in the said patent?

(Same objection.)

A. Either of them might use bromine or chlorine, in my opinion; and, in my opinion, either might manufacture it without bromine or chlorine, and it would be the same thing as if they had used them or one of them. I know not what process they actually are
36 using at the present day. My belief is, from books and reading, that bromine or chlorine is not now used in the manufacture of artificial alizarine, the reason being that bromine is now a very expensive article, and chlorine is very difficult to manipulate. Besides, the quantity of bromine in commerce is limited; so that, unless a more abundant supply of it is found, it would be difficult to keep up a stock of material commensurate with the advanced manufacture of artificial alizarine.

x 29. Do you know, of your own knowledge, what is the chemical constitution of alizarine; and if so, how did you find it out?

(Objected to as indefinite, because not defining what kind of alizarine is referred to.)

A. I have no knowledge of my own acquiring but from reading. My opinion is, that the man does not live that ever saw any alizarine pure in itself—that is, in the sense that alizarine was first used, which was to designate the coloring principle of madder.

x 30. When you answered this last question, did you suppose that I asked you whether you thought there was any man living that had ever seen alizarine?

A. I supposed that Mr. Dickerson had in his own mind some idea of a material which he named alizarine; and I meant to say that chemists are not acquainted with any dyeing material that will

answer to a definite chemical compound such as you mean when you use the word chemical alizarine.

x 31. Do you mean by all this to say that there is no such thing as a definite compound called alizarine, or only that you don't know that there is such a thing?

A. I mean to say that, prior to the invention of Graebe and Liebermann, there was no dye-stuff—that is, a material suitable for use in the practical arts of dyeing and printing fabrics—known under the name of alizarine unassociated with some other word explanatory of the particular kind of alizarine. Chemists, by dissecting a number of these different alizarines or dye-stuffs, have obtained products, a number of products, one of which they call alizarine; but what its constitution is, is a matter of discussion among them even at the present day. In fact, they find several com-
37 pounds of the same chemical formula, all different from each other, not one of which is identical with any dye-stuff made or described at the date of this patent.

x 32. Will you answer the question—yes or no, without any further argument—whether, to your knowledge, there is a substance known to chemists, called alizarine, having a definite composition, and known by a definite chemical formula?

A. If I have to answer the question yes or no, I can't answer it, as there have been a number of different formulæ worked out by different chemists at different times, each one in turn supposing that he had arrived at the bottom of the problem, and each in turn proved to be in error by subsequent investigators. Of course, I refer to alizarine as used by chemists, and not to various alizarines known as dye-stuffs. They are sufficiently definite in composition for all practical purposes, and have characteristics sufficient to distinguish the one from the other, but have never been reduced to strict chemical formula or anything approximating to it.

x 33. Do you mean by all this to swear that you have not found out yet that alizarine is established to be a definite compound whose formula is $C^{14} H^8 O^4$, and that it is so recognized and stated by William Crooks, W. H. Perkin, F. R. S., Crace Calvert, F. R. S., J. Wallace Young, "Watts' Chemical Dictionary," C. Schorlemmer, all of London; by Adolph Wurtz, M. Barthelot, of France; and by Dr. Raimennu, Dr. Auerbech, Dr. Adolph Primer, Dr. Herrmann von Fehling, J. R. Wagner, A. Strecker, all of Germany; and by Professor Josiah P. Cooke, of Harvard University, in this country?

A. I did not mean to say anything of the sort. That is the formula which chemists most generally give at the present day for one of the dissected products of certain well-known dye-stuffs. It is also the identical formula of what chemists have designated as chrysophenic acid. The chemist that first named this dissected product from dye-stuffs did not give this formula to it. But various others, as, for instance, Wolff and Strecker, gave the formula of $C^{10} H^6 O^3$; and those chemists who have simply formulated
38 what was derived by actual analysis give different formulæ, as, for instance, Schutzenberger gives the formula of $C^{20} H^{12} O^6$.

But neither the composition represented by either of these formulas will express the real composition for any useful known dye-stuff; nor do their authors pretend that they do.

x 34. Do you consider Strecker a good authority?

A. I consider Wolff and Strecker very good authorities in their day; I do yet; they did not know everything.

x 35. Do you think you know more than Strecker on the subject?

A. Of course I do, as I have read the subsequent writers on the same subject that he wrote upon; but he knew about as much in regard to dissected products of madder as any one prior to the researches of Graebe and Liebermann. Most of the authors cited in the previous question (33) have written since the invention of Graebe and Liebermann. Quite a number of them are merely quotations from some of the others.

x 36. Had you read the authors referred to in that question before you were examined here?

A. I could not say that I had read all of them, but they are all familiar names as investigators in this line of search, except those that are merely makers of books and not investigators; and the makers of books have generally quoted correctly, as far as I know, the authors from which they quote.

x 37. Is not Strecker an investigator?

A. Yes.

x 38. When you cited him as an authority for the formula that you gave, didn't you know that, in 1868, he had published the "Zeitschrift fur Chemie." Leipzig, the result of his further investigation, in which he had corrected the mistake he had made, and stated that the true formula of alizarine was C^{14} H^{8} O^{4}?

A. I was, as he then had the new light which the chemical researches of Liebermann had given upon the subject.

x 39. Do you think, then, that you know more now than Strecker did in 1868, when he published that statement; and if you
39 do, how would you correct that statement; and if you do, where did you learn what enabled you to correct it?

A. By saying that I know more, I mean to say that I know some things that he did not; and I do not know that any correction of the statement I made is necessary; but I do mean to say that these abstract formulæ are as variable as the opinions of men generally are upon mere abstract subjects.

x 40. Do you mean by all that to swear that, in your opinion, the substance which Strecker called alizarine, and the formula of which he gave, is not in reality a definite compound at all, but varies according to the knowledge or ignorance of people that are talking about it?

A. I mean to say that you cannot make any substance that would be exactly represented by that formula. The very fact that two substances so different as alizarine and chrysophenic acid have the same formula shows there is something more than mere chemical composition which gives properties to bodies, and very often very useful properties in the arts.

x 41. How do you know that chrysophenic acid has the same composition as alizarine? Have you any authority for it, except the opinion of some one person which you have cited; if so, where is that authority, and give the reference to all authorities which assert the identity of those two substances?

A. I could not now give all the authorities; I will give such as I have at hand: "Chemical News," volume XX,, page 178, London, and the authorities there cited.

x 42. Do you wish the court to understand that because you find in the "Chemical News" a formula similar to alizarine as given by Strecker, and said to represent some other substance, therefore the formula of Strecker is not a true one for alizarine?

A. I do not mean anything of that sort; but I do mean to say that chemical formulæ are either simple chemical opinions, or approximate methods of representing in brief form chemical facts; and, therefore, when Mr. Strecker or any one else gives a formula, he is only endeavoring to express his own ideas of the constitution of the material he is working with, or write in shorthand an approximation —the result of his investigation.

40 x 43. Didn't Graebe and Liebermann themselves fix the formula of alizarine as $C^{14} H^8 O^4$, and assert that what you call artificial alizarine was identical with alizarine obtained from madder, and so publish it to the world?

A. Graebe and Liebermann did contribute very materially to a knowledge of the constitution of some of the dissected products of madder and other materials; but they did not fix any formula—or publish any, at least—which will represent the product obtained by the process described in their patent, and there named artificial alizarine from anthracine.

x 44. Do you mean to swear that Graebe and Liebermann did not publish the formula of $C^{14} H^8 O^4$ as the true formula of what they call alizarine?

A. They did publish such formula; but they did not say that that formula represented the dye-stuff produced by their process in this patent. And if they had said so it would be a very easy matter to prove they were mistaken; but as they never said so, and as what they did say has been further investigated and facts ascertained which were not known then, but consistent with what they did report, I believe they were not mistaken.

x 45. Do you refuse to answer the question asked you, which is simply this: "Did not Graebe and Liebermann publish a formula, $C^{14} H^8 O^4$," as the true formula of alizarine? I don't ask whether they were mistaken or not, or whether you found out differently, or whether you are mistaken or not.

(Question objected to for indefiniteness, and not defining what alizarine has meant.)

A. They did publish that formula as a true representation of the same material to which a different formula had been assigned by Robiquet, Strecker and others.

x 46. Was not that substance called by them alizarine; if not, what name did they give to it?

A. They used the same name that the others had given to it, that of alizarine; but they did not say that this formula represented the product obtained by their patent, called artificial alizarine from anthracine.

x 47. Was not the alizarine represented by that formula derived from madder?

41 A. It was a product obtained by dissecting madder.

x 48. Was not the discussion at that time—1868—whether Graebe and Liebermann had produced by their discovery the alizarine which this formula represented, and which was obtained from madder?

A. That is a part of the discussion. So far as it goes it is correct. It scarcely gives the full scope of the question under discussion.

x 49. Did not Graebe and Liebermann insist that their process had produced the alizarine which was represented by that formula, and that it was identical with the alizarine produced from madder?

A. They did not. They dissected a certain product which they had produced, and by that dissection they obtained a derived product which they insisted was identical with a certain derived product obtained from other sources, and which that formula, C^{14} H^8 O^4, represented in chemical composition and in some of its properties; but that formula does not represent the product claimed in this patent as artificial alizarine.

x 50. Was not that "derived product" what they call alizarine? Can't you answer that yes or no?

A. Certainly, it was of that composition; but still that formula does not represent anything that anybody ever saw.

x 51. Do you mean to swear that the chemists never saw the substance which they analyzed, and of which they produced the formula referred to; and if so, how do you know that they never saw it?

A. I mean to say that no chemist ever took a compound and analyzed it, and obtained from it a percentage composition which was identical with the percentage composition given by this formula. To obtain the formula two things always have to be assumed. One is to neglect a part of the results obtained by actual analysis as probable errors; and the other is to reason from analogies, so as to assume that the elements found by analysis actually entered into the compound analyzed in certain multiple proportions. Taking this very formula as an illustration, C^{14} H^8 O^4, the same result would be given by analysis if the formula had been C^7 H^4 O^2, or if it had
42 been C^{21} H^{12} O^6, or if it had been C^{28} H^{16} O^8, or an infinite number of formulæ where the carbon, hydrogen, and oxygen are in the same relative proportions; so that every formula, as published, represents only approximately the actual result of analysis, and generally carries with it some theoretical idea depending upon the peculiar doctrines of chemistry in vogue at the time.

x 52. Do you mean by all that to swear that this substance does not contain the three elements indicated by that formula—namely, as 14 is to 8 and to 4?

A. I mean to say that the chemists who have analyzed the derived product called alizarine never get out a percentage result which will be the same as the calculated results from the formula. Hence the great variety of formulæ that have been given from time to time from the same material.

x 53. Do you know whether it is true or false that the formula expresses truly the relative proportions of the different substances in alizarine?

A. It represents truly what is most generally believed at the present time.

x 54. Don't you know, so far as you can know from the published accounts of it, that Graebe and Liebermann arrived at their process by first converting madder alizarine into anthracine, thus affording strong evidence that anthracine could be converted into alizarine?

A. They did do something of that kind; but that has nothing to do with this dye-stuff. Before the discovery of the aniline dyes, Dahme and Unverdorven, by treating indigo, obtained a new substance which was called aniline, from *anil*, the Portuguese word for indigo. This gave a hint which finally led to the well-known aniline dyes. And aniline was obtained from coal-tar, and it was an identical composition to that obtained from indigo; still, no one pretends that the aniline and indigo dyes are the same materials, although by dissecting them you can obtain a number of identical products. So Graebe and Liebermann found that, by certain treatment of madder dyes, they could obtain anthracine. They worked upon this hint. They investigated the commercial anthracine, and, as a result of their investigations, produced the new dye-stuff named by them artificial alizarine, and described fully how to pro-
43 duce it in this patent. They then went further, and dissected this new product, and obtained a material which they believed had the composition C^{14} H^{8} O^{4}. This they compared with the dissected product from madder; and they found the two to have the same composition so nearly as to lead them to believe that they were the same thing. Since then other investigators have found that the artificial alizarine of this process is quite a complex material, and one giving it great value in the art of dyeing.

(Counsel for defendants objects to the argument of the witness and requests the counsel for the complainants to have it all struck out, as not responsive to the question.

Counsel for complainants replies that he considers the answer drawn out by the question, and as not improper, and declines to strike it out.)

x 55. When Graebe had produced anthracine from madder alizarine, do you suppose that, if he had reconverted that anthracine into alizarine, the alizarine thus produced would be different from what it originally was—namely, madder alizarine?

A. I would suppose a man would not guess anything of the kind; for, as aniline was derived from indigo and also from coal-tar products, and when this aniline was converted into dye-stuff the aniline dyes were different from indigo, but capable of replacing it in some connections, I believe it would be reasonable to suppose that anthracine dye-stuff would be a different material from the madder dye-stuffs most resembling them.

x 56. Suppose, when indigo had been converted into aniline, the chemist had reconverted that aniline into indigo, would you expect the product to be different from the indigo as it originally was?

A. Inasmuch as no chemist has ever converted aniline into indigo or the artificial alizarine from anthracine into madder, I have no opinion to offer upon the subject.

x 57. Did you, as examiner in the patent office, allow the reissue of this patent, No. 4,321, which you are now engaged in trying to sustain?

A. I did.

44 Re-direct:

Re-d. 58. Please hear the officer read question and answer x 15, and state who showed you the samples referred to, and what were they samples of?

A. The samples given by Mr. Pickhardt was in September, 1874; he gave them to me as artificial alizarine from anthracine, without saying how they were made.

Re-d. 59. What did you do with the samples Mr. Pickhardt gave to you?

A. I analyzed them, compared the results with the descriptions given by chemists of Graebe and Liebermann's artificial alizarine, and found them to be that dye-stuff.

Re-d. 60. State if you also compared said samples with any madder products or derivatives, and if so, state the result of such comparison?

A. I did. Mr. Pickhardt gave me at the same time some extract of madder, such as is used by dyers; I examined them both physically, chemically, and practically, and found the matter extract to be a clearly distinct material from the artificial alizarine.

Re-d. 61. You say, in answer x 29, that your opinion is that the man does not live that ever saw any alizarine pure in itself, that is, in the sense that alizarine was first used, which was to designate the coloring principle of madder; please describe more fully in what sense that word was so used and what coloring principle you refer to?

A. Alizarine is a word coined from the Arabic and modern Greek names for madder. There are many such similar words in chemistry. They come under the class of what is known as arbitrary or fancy names. As the madder plant had been known from time immemorial as a valuable dye-stuff, it was supposed that it contained some one substance which, if it could be extracted, would possess

all the virtues of the madder plant as a dye-stuff. The first definite, or, at least, approximately definite, compound was that obtained by Robiquet and Collin. Other chemists continued the investigation. This really crystallized compound, obtained from the madder plant, was named alizarine, and was supposed to contain all the color
45 of the madder. This, however, was soon found to be an error; and it is now, and has been for a long time, agreed that madder and its several preparations owe their value as dye-stuffs to two, three, four, or more different materials, either existing naturally in the madder or produced by the aid of chemicals, heat, fermentation, and the like. So that there are many alizarines known as dye-stuffs; no one, however, that any of the chemical formulæ for alizarine represent. The trade names of the dye-stuffs are never simply the word alizarine, but such as commercial alizarine, green alizarine, yellow alizarine, and finally artificial alizarine. Every one of these dye-stuffs has characteristics which clearly distinguish it from all the others, and they are never confounded in the trade or by the managers of dye and print works.

Re-d. 62. You say, in answer x 45, that Graebe and Liebermann published the formula C^{14} H^{8} O^{4} as a true representative of the same material, to which a different formula had been assigned by Robiquet, Strecker, and others. Was that material, of which you say that formula was a representative, the material described and specified in the claim of complainants' patent No. 4,321, and if not, what was it?

A. It was not the material named in the claim of that patent and defined in the body of the specifications by giving full and exact directions how to make it. The material to which Graebe and Liebermann gave the formula C^{14} H^{8} O^{4} is a crystallized compound capable of being wholly sublimed without change, and is that which had been prepared with more or less purity by Robiquet, Shunk, Strecker, Shutzenberger, and other chemists.

Adjourned to Thursday, the 21st of October, 1875, at 9.30 a. m.

THURSDAY, 21*st October*, 1875.

Met pursuant to adjournment. Present: Counsel as before.

Re-direct examination of Professor Hedrick continued:

Re-d. 63. What does the formula C^{14} H^{8} O^{4} require percentically; I mean what percentage of those different substances does that formula require?

46 A. Seventy per cent. of carbon, 3 33-100 of hydrogen, and 26 67-100 oxygen.

Re-d. 64. You have said, in your cross-examination, that that formula has been ascribed to chrysophenic acid as well as to alizarine. Are there any other substances to which that formula is ascribed? and if so, please name them.

A. Five other substances have, as near as has been ascertained, the same formula. E. Kopp, in his report on the chemical products

at the Vienna exposition, published in the *Moniteur Scientifique* for June, 1875, described fully the seven different materials which this formula represents. These are alizarine, xanthopurpurine, isalizarine, quinizarine, chrysophenic acid, anthroflavone, and frangulic acid.

Re-d. 65. Are these substances to which this same formula is ascribed different one from the other in properties or qualities, or are they the same one with the other?

A. They each have characteristic properties which distinguish them one from the other.

Re-d. 66. Does that formula describe those seven articles or either of them in a commercial form, or in what form?

A. It does not represent them in a commercial form, but is what is called by chemists the rational formula of the substance, prepared, as nearly as possible, chemically pure.

Re-d. 67. Would the substance called alizarine, when so prepared chemically pure, be of any practical value as a dye-stuff?

A. No such substance has ever proven to be of any practical value as a dye-staff All the dye-stuffs known to the arts are complex materials, and the value of each one depends, to a great extent, upon the form in which the materials are brought together. In the most complex of these useful dye-stuffs, such as madder extract, commercial alizarine, garancine, the chemists have never as yet agreed as to what are all of the substances mixed together in them. Nor has it been possible to form them synthetically—that is, to collect the parts from different sources and put them together.

Re-d. 68. You say that all the dye-stuffs known to the arts
47 are complex materials. Do such dye-stuffs contain other substances than those represented by the formula $C^{14} H^8 O^4$?

A. They do.

Re-d. 69. You have given the percentage value of the formula $C^{14} H^8 O^4$? Can any one, by taking the percentage, which you gave in your answer 63, of carbon, hydrogen, and oxygen, produce the substances which are said to be represented by the formula $C^{14} H^8 O^4$ or either of them?

A. They cannot. These elements cannot be united by any process known so as to form any one of the substances now known as corresponding to this formula.

Re-d. 70. You was asked in cross-examination about Graebe and Liebermann's treatment of alizarine with zinc dust. State, if you know, whether it was pure alizarine which they treated with zinc dust and produced thereby anthracine.

A. It was not pure alizarine, as all authorities agree that at that time pure alizarine had never been prepared by any method then known.

Re-d. 71. Did they, in that treatment of alizarine, or what they called alizarine, with zinc dust, obtain anthracine only?

A. They obtained other products besides anthracine.

Re.d. 72. Can anthracine be obtained from other substances also

by treating such substances with zinc dust? and if so, name some such other substances.

A. It can be obtained by treating quite a number of other substances with zinc dust. E. Kopp says, in the *Moniteur Scientifique*, to which I have already referred, that it can be obtained from quinizarine, and through anthraflavone, frangulic acid, purpurine, anthrapurpurine, anthrachrysome, rufiopine, and rufigallic acid.

Re-d. 73. Have all those substances that you have just mentioned the same chemical formula?

A. They have not.

Re-d. 74. Have any of these substances been produced from anthracine?

A. Some have, and some have not.

Re-d. 75. You was asked, in cross-question 56, about the reconversion of aniline into indigo. Can such reconversion be accomplished? and give your reasons for any opinion you may express.

48 A. It cannot, by any method known up to the present time.

As a general rule, when an organic compound is broken up or changed by chemical treatment, so as to form derived products, it is not possible to take those derived products, and reconvert them into the original substance from which they were obtained. As, for example, alcohol may be obtained from wheat and other grains, from fruits, and from many different substances, by means of fermentation, treating with acids and other chemical processes; but it is not possible to reconvert the alcohol into the original grain, fruit, or other substance from which it was originally produced. As another example, milk may be separated into butter, cheese, milk, sugar and other products, and some of these products, as the sugar, converted into lactic acid; but it is not possible to reconvert these derived products into milk again, either by taking any one of them or the whole of them.

Re-d. 76. You said in your answer 62, that the material represented by the formula $C^{14}\ H^{8}\ O^{4}$ is a crystallized compound, capable of being wholly sublimed without change. Can the material contained in this bottle, Complainants' Exhibit Hedrick, or in Exhibit Browne No. 2, be wholly sublimed without change?

A. It cannot, only a fraction of it, and what does sublime has properties which clearly distinguish it from similiar sublime products from madder, or madder preparations known as dye-stuffs previous to Graebe and Liebermann's invention.

Adjourned to 9.30 to-morrow, Friday, the 22d of October, 1875.

OCTOBER 22, 1875.

Counsel present as before.

Continuation of examination of Professor HEDRICK.

Re-d. 77. Can the patented article described in complainants'

patent No. 4,321, and specified in the claim, be wholly sublime without change?

A. It cannot.

Re-d. 78. What properties clearly distinguished that part which does sublime from the sublimed products of madder preparations, as stated in your answer 76?

49 A. It requires a higher temperature to obtain the sublimate from the artificial alizarine than from the several madder alizarines, and it will bear a higher temperature without decomposition; it also is deficient in some materials from the madder product, such as purpurine.

And the witness, on being again cross-examined by Mr. Dickerson, defendants' counsel, says:

Re-x 79. State the chemical constitution in a formula of the extract of madder which you analyzed, and which Mr. Pickhardt gave you.

A. There is no formula that would represent it. These chemical formulæ are only applicable to crystalline materials. This madder extract is a very complete mixture, containing very little crystalline matter in the shape it is used as a dye-stuff.

Re-x 80. State the different elements which you found by analysis to exist in the madder extract given you by Mr. Pickhardt, and give the proportions of each.

A. I did not make a destructive analysis of it; that is, reduce it to its elementary principles. They are generally, however, supposed to be carbon, hydrogen and oxygen in varying proportions, with some small proportion of earthy and metallic salts, in no fixed proportions.

Re-x 81. State the different elements which you found by analysis to exist in the dye-stuff marked Exhibit Hedrick, and give the proportion of each.

A. I did not make destructive analysis of this; that is, reduce it to its elements. It is, however, well known that artificial alizarine is composed almost wholly of carbon, hydrogen and oxygen, with slight variations in the proportions.

Re-x 82. Inform the court what elements there are in one of these substances that you did not analyze, which are not to be found in the other substance which also you did not analyze, and at the same time tell the court how you know that there is any element in the one not found in the other.

A. I did not say that there was any element in the one not in the other. The dye-stuff, or any useful product generally, I
50 might say, always depends more upon how the elements are put together than upon what they are. As for example, there is no difference between the elements in a batch of sulphur and caoutchouc, or India rubber before it has been vulcanized, and after it has been vulcanized. There is no difference in chemical constitution between red phosphorus and ordinary phosphorus; that is, the element in each is just the same. They are, however, quite differ-

ent substances in the arts, and the conversion of one into the other is regarded as among the most important inventions.

Re-x 83. You said that pure alizarine would not be of any practical value as a dye-stuff. Did you mean by that, that pure alizarine would not dye cloth?

A. In the first place, pure alizarine was never made prior to the date of Graebe and Liebermann's invention; but taking the nearest dissected products, which are the things that chemists are generally speaking of when they use the word, alizarine is not a practical dye-stuff, for the reason that it is only slightly soluble in water, and the cloth would be spoiled by the undissolved particles or crystals sticking to it. The expense would also be enormous in preparing it, and when prepared it would give no valuable new result as a dye-stuff, therefore it is not a dye-stuff.

Re-x 84. Do you mean to swear that chemically pure alizarine cannot be thoroughly dissolved in water?

A. If you mean by chemically pure alizarine the various crystallized products that have been produced by different chemists at different times, which have great variability in their properties, I do not mean to say that you could not dissolve it if you put enough water with it, and kept it in the water a sufficient length of time at the proper temperature; but it would not be a useful dye-stuff, nevertheless.

Re-x 85. Do you mean to swear that what you call chemically pure alizarine in your 67th answer, if dissolved in water, would not dye cloth?

A. I have already stated that it could be dissolved under certain conditions; but that under these conditions it possesses no value
51 as a dye-stuff, and has not been used as a practical material for dyeing and calico printing. You could stain your hands with it; you could produce some colors upon cloth; but not any result that would entitle it to be called a useful dye-stuff.

Re-x 86. Did you ever experiment with chemically pure alizarine to ascertain its effect in dyeing cloth?

A. I never tried to dye cloth with the sublimed products from either madder alizarine or artificial alizarine; but I have tried their solubility, and I have spoken with practical printers and dyers in regard to their applicability as dye-stuffs?

Re-x 87. Who told you, and when did he tell it to you, that in his opinion chemically pure alizarine would not dye cloth?

A. Some of the workmen in Hamilton Print Works in August last, and I believe also some of the witnesses that were summoned in this room in some other case. Besides, I have inquired among the sellers of dye-stuffs, and I have read the standard treatises on dyeing and calico printing, and I do not find that a material known as chemically pure alizarine has been either described, sold, or used as a dye-stuff.

Re-x 88. What was the workman's name who told you that chemically pure alizarine would not dye cloth?

A. I do not know; it may have been Mr. Harley, Mr. Raoch, or some other person.

Re-x 89. Whoever this unknown person was, did he tell you that he had experimented with chemically pure alizarine, and found it would not dye cloth?

A. He did not.

Re-x 90. What did he say that enables you to swear, as you have done in this case, that chemically pure alizarine would not dye cloth?

A. He mentioned this fact, the insolubility of these crystals, and their sticking on cloth and spoiling it.

Re-x 91. Then did not he tell you that he had tried that experiment and ascertained that fact?

A. He did not say anything in regard to it, whether it was his own experiment, some other person's experiment, or something that some one had told him, or something that he had obtained by reading authorities on the subject.

52 Re-x 92. In all your researches on this subject, did you ever find it in print, and if so refer me to the book in which it is stated, that chemically pure alizarine will not dye cloth successfully, because the crystals will stick in the cloth and spoil it?

A. I could not state positively that I have seen it; but my impression is that I have. I can, however, state positively, that no one has ever alleged that he could practically carry on dyeing and printing calico with chemically pure alizarine, meaning thereby the various crystalline substances described by chemists under the general name of alizarine.

Re-x 93. Is not it the commonly stated opinion, to be found in chemical books generally, that alizarine is the "coloring principle" of madder?

A. It used to be so stated, but is now well known not to be correct; and even when it was so stated, it did not mean these several sublimed crystalline compounds that have produced by breaking up madder dye-stuffs, but only to a supposititious substance which they inferred must be in the madder, though they were never able to get it out.

Re-x 94. What author of recognized authority within the last ten years has denied the proposition that alizarine is the coloring principle of madder? Refer me to an authority which contains that denial.

A. I do not know any that asserts that it is.

Re-x 95. Don't Graebe and Liebermann both, in their publications, say that alizarine is the coloring principle of madder?

A. They do not. They and all other modern chemists maintain that madder owes its value as a dye-stuff to a number of materials; scarcely any two authorities agree as to the exact number; and even then, when they speak of alizarine as being in madder, they do not mean these crystallized sublimated compounds which are not used as dye-stuffs.

Re-x 96. Do not they all agree that alizarine is one of the coloring principles of madder?

A. They do not agree that this sublimed crystallized prod-
53 uct is one. The very act of subliming the natural products of madder materially changes their character. And in dyestuffs of the alizarine class the chemists are now almost wholly committed to the opinion that these anthracine products, known under the name of artificial alizarine, are different from the madder alizarines.

Re-x 97. Question repeated.

A. I could not answer the question unless I was informed what is the thing that is meant to be signified by the word alizarine.

Re-x 98. Do you think you understand the patent No. 4,321?

A. I believe I do.

Re-x 99. Point out in that patent that part of it which describes the substance which it indicates by these words, namely: "We collect the yellow flocks of alizarine thus obtained on a filter and wash them with water," and inform the court just what that substance is which is called alizarine, what are its elements and proportions as the patent informs you, or any other persons skilled in the art, so that you might know it when you saw it or analyzed it?

A. The article itself is named artificial alizarine from anthracine. It is defined in that part of the specification which tells how to make it. It tells what to begin with, referring to the known substances at the time, how to treat that in all its stages until the finished product is obtained. There is no more certain mode known for describing material which did not exist before than that of telling properly skilled persons how to make it, starting with the materials known at the time and properly designated. This the specification gives, beginning with the words: "We first change anthracine into anthrakinon," and so forth, and ending with the words "on a filter and wash them with water." As the laws of chemistry are fixed and invariable, this will enable chemists all over the world who can read and understand the specification to make this new product.

Re-x 100. As one of the chemists of the world who has especially studied this subject, will you now tell the court what is the chemical constitution of the alizarine which results from following the process described in this patent; give the elements and their proportions?

54 A. It would be just as impossible to describe this product by tearing it to pieces and getting out each elementary substance by itself as it would be to separate one from the other all the elementary substances which enter into a piece of flesh, or to describe what it is that makes vulcanized rubber different after it is cool from the same material before it has undergone the process of vulcanization by separating its elements. This new product of Graebe and Liebermann has been carefully studied by the chemists of Germany, France, and Great Britain, and the properties which distinguish it ascertained. This knowledge is of great use to any

chemist who is required to say whether a particular sample of any substance is that material or some other; whilst the burning up the material, as would be required to give an ultimate analysis showing each element and its proportion, would not give the slightest information as to what the material really had been.

Re-x 101. Do you mean to swear that a competent chemist could not, by analysis, determine the exact quantity and proportion of each element contained in a sample of alizarine produced by following the process of the patent No. 4.321?

A. They could get it approximately. But if they did not know before they analyzed the material what it was, this operation would not inform them, because, after such taking to pieces or analyzing had been made, the elements would all be thrown together again; and they would then be the same elements and in the same proportion, but they would not be artificial alizarine. In fact, there are a large number of substances that are composed of exactly the same elements in the same proportion, which, however, are very different substances.

Re-x 102. Couldn't the constitution of this alizarine be just as well ascertained by a competent chemist as the constitution of the madder compound which is used for dyeing?

A. I think it could, and a little easier, because it is not so complex.

Re-x 103. Would this process always produce the same product if strictly followed, according to the patent?

55 A. Certainly it would, as the laws of chemistry do not change.

Re-x 104. Would it be the same in color and the same in its dyeing properties?

A. It would, to all practical purposes.

Re-x 105. Now, don't you know that a great variety of dye-stuffs under the name of artificial alizarine are manufactured from anthracine, each one differing from the other in its color and dyeing qualities, and each one producing results in dyeing which the other cannot produce?

A. I know that artificial dye-stuffs sold under the name of artificial alizarine slightly vary among themselves, just as the madder extract made by one manufacturer or the commercial alizarine or garencine made by different persons will slightly vary among themselves, but are all still substantially the same thing. A baker never makes two batches of bread out of the same barrel of flour that are identical in every respect. Vulcanized rubber varies, between certain limits, without ceasing to be vulcanized rubber. That which was first made by Goodyear was not quite up to the standard of what it is to-day. I have noticed only variations of this sort in the different samples of artificial alizarine which have come under my notice.

(Counsel for the defendants requires counsel for the complainant to restrain the witness from such impertinent arguments as the last question contains, and to confine him to answering the questions, and

to strike out all the last answer that relates to bread-baking and vulcanized rubber.

Counsel for complainants replies that, in his judgment, the witness has not gone beyond his right or his privilege in explaining the character of the variations which are referred to in the last question.)

Re-x 106. Didn't you know it to be true, when you answered the last question, that the varieties in color and in dyeing quality found in alizarine made from anthracine are not the results of accident, as a batch of sour bread is, but are intentionally so produced by variations in the process of manufacture?

56 A. I did not use the word "sour bread." I did not refer to anything of that kind, but I do not know that any one professes to have made an artificial alizarine from anthracine that did not go through reactions upon the anthracine, which are only equivalents of those used by Graebe and Liebermann. The quality of the article produced by different manufacturers does vary, according to what is stated by writers in technical chemistry; but all these variations, or at least most of them, are only such as would naturally arise among different chemists who should pursue the manufacture. It is well known that the artificial coloring matters made by different chemists always vary more or less.

Re-x 107. Do you mean by all that to swear that, by following the process described in this patent, the alizarine produced would sometimes dye violet shades and sometimes dye scarlet ones, as it might happen by chance?

A. No, not as it might happen by chance; but this great variety of shades that is produced by this material is due to the particular mordants that are used with it. I only referred to such variations as are known to exist between the madder grown in one country and that grown in another, where they have been prepared for use exactly alike. I suppose that a person might take this Graebe and Liebermann product, and subject it to some further treatment which would modify and change it to some extent—very likely improve it for some purposes, just as the manufacturers of hard rubber, taking up the invention of Goodyear, succeeded in changing it in color and other respects; but I know that all the artificial alizarines that I have seen have only these subordinate variations, and none such as would make them be called a different material.

Re-x 108. If the change in color and dyeing capacity from the color and dyeing capacity of the alizarine described in the patent does not change the character of the material, what means are there for knowing whether any given sample is the same as the alizarine described in the patent?

57 A. Unless some actual case should arise upon which it would be possible to pass judgment, I do not see how I could give any general answer of this kind. A person who had seen hard rubber a great many times, and found it always black, might be a

little bothered at first to say whether a red specimen that was shown him, such as the dentists use, was really hard rubber or not.

Re-x 109. Is the color and coloring capacity of a sample of alizarine a test by which it can be known whether it was made by Graebe's process or some other? If so, describe the test so that the court may understand it.

A. There is no one single test that will settle everything.

Re-x 110. Is color a test at all; and if so, what is the color by which it may be known whether the alizarine was produced by the process of the patent or some other process?

A. It is not. A few drops of ink dropped into a specimen of artificial alizarine would change its color. It would even change the color when it went to be used as a dye-stuff. I would say then that where a change has appeared which would seem to indicate that the material was not that which would result from the application of the process of Graebe and Liebermann or a substantial part of the product, and that it could not be accounted for without supposing that the material was something wholly different, then it must be considered some other material.

Re-x 111. Does the patent furnish any means whatever for identifying the product there called alizarine, except that it is made by the process there described? If so, point out those other means of identification.

A. It gives the surest of all means, because when a chemist does just what is told him to do there, he will get a substance which he will rest assured is artificial alizarine; and I do not know any other good method by which an entirely new product can be described, for if you could say it was just like some other material in all respects that would not distinguish it from that material. But after you had made the material one time you can say whether another sub-
58 stance is the same by comparing it with the material that you have made. There is another great difficulty in defining, by any other means than that of giving the process by which to make it, of any entirely new substance. It is this, that it is only after it becomes known and studied that its essential characteristics are ascertained. Sometimes it takes a long time to arrive at all of these. The patent, besides the process which defines the product, goes no further in this direction, for it was wholly unnecessary, except to state how the material can be applied to one useful purpose.

Re-x 112. Do you mean by all this argument to say that the patent furnishes any means of identifying the products except the description of the products by which it is made; if so, point out to the court what these means of identification are?

A. I do not know of any.

Re-direct:

Re-d. 113. Did you in your last answer include in the description of the patent the sentence beginning with the words, "we collect the yellow flocks," &c.?

A. I did. When you have collected these yellow flocks, which the specification will furnish you if you follow its directions, you will have first-rate means of identifying the product.

Re-d. 114. Are not those means of identifying the product to which you have referred in your last answer, additional to the means furnished by the process?

A. They may be so considered; but I was taking all the information the description furnished, even the indications as to how the matter looks as it progressed. I take it that the man who wishes to know what the invention is, must take the specification and read it with an honest endeavor to find out what it really is.

Re-cross:

Re-x 115. Is not all alizarine that is used for dyeing artificial, whether it is produced from madder or from anthracine?

A. That is a very much disputed question—a great deal has been written on both sides; but among dye-stuffs we always avoid
59 ambiguity, as there are so many to which the name alizarine has been applied, so as to designate a whole genus of dye-stuffs; so, as I said, to avoid ambiguity, the trade products are designated by some additional word.

Re-x 116. Is it disputed, and by whom, that any merchantable article used as a dye-stuff is an artificial product? If so, which of the various forms of madder alizarine is said to be a natural product?

A. They are all artificial in the sense that they are prepared for use by more or less treatment; but the word artificial as applied to dye-stuffs of this class is the short description or name of this article produced by Graube and Liebermann.

BENJ. S. HEDRICK.

Adjourned to to-morrow, Saturday, the 23d day of October, 1875, at 10 o'clock a. m.

OCTOBER 23*d*, 1875, 2 p. m.

Present: Counsel as before. Met pursuant to adjournment.

Professor B. S. HEDRICK re-called by complainants.

Q. 1. In your former examination in this case you stated in answer to question 12 that you had "examined the appearance of the two materials in paste or semi-liquid form." Please hear the officer read that question 12 and your answer thereto, and state what the materials were which you speak of in that answer.

A. One of the materials was this bottle, Complainants' Exhibit Hedrick, R. E. S., examiner, Oct. 19, 1875, and part of its contents which I had taken from the bottle marked Exhibit Browne No. 2. The other was a bottle of artificial alizarine which I obtained from Mr. Pickhardt in September, 1874, and which I had examined and experimented upon a good deal before I had received Exhibit Browne No. 2.

Q. 2. Were the contents of that other bottle which you call arti-

ficial alizarine known to you to be artificial alizarine such as is described and specified in the claim of the reissued patent No. 4321?

A. I found them to be according to all the tests of that article, as given by writers and investigators upon the subject.

60 Q. 3. Have you, since your former examination was concluded yesterday, made any further comparison between the contents of the bottle marked Complainants' Exhibit Hedrick, and the patented artificial alizarine which is specified in the claim of said reissued patent?

A. I have.

Q. 4. Where, and from what source, did you obtain such artificial alizarine specified in said reissued patent?

A. I made it at the laboratory of the Stevens Institute to-day from a quantity of material of which this is a sample, which I now produce, by following the directions given in the patent itself; it is bibromanthrakinon.

(Counsel for complainants offers in evidence the bottle and its contents produced by the witness, and the same are marked Bibromanthrakinon Exhibit Hedrick, R. E. S., examiner, Octo. 23d, 1875.)

Q. 5. Produce, if you can, some of the artificial alizarine which you say in your last answer you made by following the directions given in the patent, and also produce some of the material, if any, made by you in any intermediate stage of the process.

A. The contents of this small bottle which I now produce, and which is marked "Yellow Flocks," is the final product which I made by that process; and the contents of this other bottle is a violet solution, which I obtained by dissolving and filtering a mass of a deep blue color, obtained by treating bibromanthrakinon in the manner described in the patent.

(Counsel for complainants offers in evidence the bottle and contents marked Yellow Flocks, and the same is marked Yellow Flocks, Exhibit Hedrick, R. E. S., examiner, Oct. 23d, 1875. Counsel also offers in evidence the bottle and contents of violet solution produced by the witness, and the same is marked Violet Solution, Exhibit Hedrick, R. E. S., examiner, Oct. 23rd, 1875.)

Q. 6. What is that bibromanthrakinon of which you have produced a sample?

A. It is a material that can be produced by several different methods; but one of the simplest is that of oxydizing the tetrabromanthracine of Anderson, and is one of the materials mentioned in said reissued patent.

61 Q. 7. You say, in answer 3, that you have compared the contents of Exhibit Hedrick with artificial alizarine. Was that comparison made with the artificial alizarine in the exhibit marked Yellow Flocks?

A. It was.

Q. 8. State what was the result of your comparison of the contents of Exhibit Hedrick with the material called Yellow Flocks exhibit, as to similarity or dissimilarity.

A. They are the same thing; they are essentially the same thing.

Cross examined by Mr. Dickerson:

x 9. You state, in answer to interrogatory 5, that the contents of the bottle is a violet solution, which I obtained by dissolving and filtering a mass of a deep blue color, obtained by treating bibromanthrakinon in the manner described in the patent. Please state what is the final result obtained by following the processes described in this patent.

A. The yellow flocks which are called artificial alizarine.

x 10. What other process or processes did you employ beside those described in the patent when you obtained this violet solution?

A. I did not employ any. I followed exactly the directions of the patent.

x 11. Do you mean, then, to state that this violet solution was obtained by following the process described in the patent to a certain stage, and that by continuing the process to its termination you obtained the yellow flocks?

A. I did; and any one can obtain from this solution such yellow flocks by precipitating with an inorganic acid or by an organic acid.

x 12. Please state where in the patent this violet solution is described.

A. I quote from the specification: "We then dissolve it in water and filter the violet solution." The "it" in this sentence refers to the "mass" of a "deep blue color."

BENJ. S. HEDRICK.

Adjourned to Monday next, the 25th October, 1875, at 3 o'clock p. m.

OCTOBER 25, 1875.

Complainants rest.

62 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE and CARL RUMPFF. } In Equity.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
HAMILTON MANUFACTURING COMPANY. } In Equity.

In the first above mentioned suit, the defendants admits that prior to the beginning of said suit, and after the first day of March, 1872, they sold a product the same as that examined by Prof. Hedrick and Prof. Morton, and referred to by said Hedrick in the 10th answer of his deposition in said suit, and by said Morton in answer to the 16th question of his affidavit in said suit.

In the second suit above mentioned, the defendants admit that prior to the beginning of that suit, and since the first day of March,

1872, they used a product the same as that examined by Prof. Hedrick and Prof. Morton, and referred to by said Hedrick in the 10th answer of his deposition in said first-named suit, and by said Morton in answer to the 16th question of his affidavit in said first-named suit.

In both of said suits the defendants admit that the complainants are a corporation, as is alleged in said bills of complaint.

It is agreed by all parties in each of the above suits that duplicates of the pleadings already filed in the first of the above-mentioned suits shall be duly filed as the pleadings in the second of said suits.

Complainants consent that the defendants in the first of
63 the above cases may amend their answer as follows:

"And the defendants, further answering, allege that the invention set forth and described in said reissued letters patent (more particularly set forth in the bill of complaint herein), had been previously patented in foreign countries, and that the foreign patents so obtained for the same invention in foreign countries have expired, and that therefore the said reissued letters patent are by the laws of the United States limited to expire at the same time with the said foreign patents, and are therefore no longer valid or in force."

The defendants in the above suits further consent: "That the filing of a replication to said amended answer be, and the same is hereby waived, and the replication already filed shall be considered and taken as the replication to said amended answer."

Both parties to the above suits consent that all testimony already taken and hereafter to be taken in either of the above suits shall be considered as taken in both of said suits.

Defendants consent that the affidavit of Prof. Henry Morton in the first of said suits, of which a copy has already been served upon defendants' counsel, shall be admitted as direct testimony in both of said suits, subject to the right of defendants' counsel to cross-examine Professor Morton.

It is further consented by all parties that the complainants shall have until December 10th, 1876, to put in the further perliminary testimony. Also, that the defendants shall have until February 1st, 1877, to put in their testimony in reply, and that complainants shall have until March 1st, 1877, to put in evidence in rebuttal of any new matter put in evidence by the defendants.

All parties further agree that after the testimony under this agreement is completed, they will proceed to trial of that one of the above cases which can be first heard, it being the object of each party to secure a decision on the merits of said suits.

New York, Nov. 11, 1876.

J. VAN SANTVOORD,
Compl'ts Sol'r in both suits.

DICKERSON & BEAMAN,
Sol'rs for def't in both suits.

64 U. S. Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, and CARL RUMPFF. } In equity.

CITY AND COUNTY OF NEW YORK, *Southern district of New York,* } *ss.*

HENRY MORTON, being duly sworn, deposes and says that since he made his affidavit of March 29th, 1876, in this case and hereto annexed, he has made the investigations, tests and comparisons referred to in his said affidavit as being in progress, and that the results thereof are contained in the following answers made by him to the questions asked, and that accompanying said answers are duplicates of the exhibits No 1 to 13, therein referred to:

Question 1. What is your name, age, residence and occupation?

Answer. My name is Henry Morton: age, 39; residence, Hoboken, New Jersey; I am president of the Stevens Institute of Technology of that place.

Q. 2. Have you given any special attention and study to the subject of chemistry?

A. From my boyhood I have occupied myself chiefly with the study and investigation in the subjects of chemistry and physics. I have occupied the chair of chemistry in the university of Pennsylvania and in the Philadelphia Dental College. I have made and published in the scientific journals of this country and Europe several investigations in these subjects.

Q. 3. Have you read and do you understand complainants' patent, reissue No. 4321?

A. I have, and I believe that I do.

Q. 4. What special opportunities have you had of acquiring knowledge in reference to the production of artificial alizarine, its composition, and the composition of commercial alizarine derived from madder?

65 A. In the early part of 1873 I had the good fortune to discover in the last products of the distillation of petroleum a new solid hydro-carbon, which has received the name Thallene, and which resembles in many respects anthracene, and in fact is probably isomeric with that body. In the course of my study of this substance, I was led to hope that it might prove convertible into artificial alizarine like anthracene, and to place myself in a position to determine this, I found it desirable to make in my laboratory the various derivatives of anthracene, including artificial alizarine, so that I might be familiar with the reactions of this process, and be enabled to compare them with those I might obtain with my new body. This work has been carried on pretty continuously from that time until the present, and has also been supplemented by numerous experiments in the separation and purification of various bodies constituting the commercial preparations of madder and the dye-stuff

known as artificial alizarine, and constituting, as I understand, the subject-matter of the patent above referred to.

Q. Were your experiments and researches which you have alluded to in your last answer commenced before you became an expert in this cause, and were they independent of this case?

A. They were commenced long before, as I was not retained in this case until the latter part of 1875, and only a portion of those made since that time have reference to this case.

Q. What is alizarine?

A. The word alizarine, like many other similar names, is used in a strict and in a general sense. In its strict or scientific sense it is used to indicate a definite chemical compound which may or may not have been obtained in a perfectly pure state, but whose composition, if perfectly pure, is assumed to be carbon 14, hydrogen 8, oxygen 4. Moreover, the name, as so used, is understood to imply not only that these elements are present in the above relative proportions, but that they are grouped in a certain definite way as regards their relative positions. In the second place, the term alizarine is used by writers generally to describe any mixed substance which is believed to contain, as one of its constituents, in effective proportion, this perfectly definite though, in a certain sense, ideal body above described. In illustration of the use of this term in its most general way, I would refer to Auerbach, "Das Anthracen und seine derivate," page 98, wherein, speaking of a very impure mixture containing many things besides alizarine in the strict sense, he says (which I translate as follows): "The alizarine which separates is colored a dark orange brown." Again, Perkin, in the Journal of the Chemical Society, vol. 23, page 140, uses the following expression: "The coloring matter obtained either by Graebe and Liebermann's original process or from the sulpho-acid of anthraquinone, I have invariably called alizarine."

66 And similar quotations could be multiplied indefinitely.

Again, the term alizarine with a prefix, as, for example, green alizarine or yellow alizarine, is used to indicate a substance not regarded by any means as pure by the author using the term, as, for instance, in Crook's Handbook of Dyeing and Calico Printing, London, 1874, page 246, I find as follows: "If the mother liquor is now allowed to boil for two hours the so-called green or crude alizarine separates out and is deposited in twenty-four to thirty hours as a greenish black mass." Also on page 266 the word alizarine is used in the same general sense about ten times.

Again, in reference to yellow alizarine, we find that Schützenberger, "Traité des matières colorantes," French edition, vol. 2, pp. 164 and 165, 1867, says as follows: "The green alizarine treated with alcohol or wood spirit dissolves partially and gives solutions of very strong brownish yellow color. By decanting the clean liquid and evaporating, or, better, by distilling it, we obtain as a residue a brownish yellow alizarine tolerably pure;" and on page 165, in speaking of the extract of green alizarine in coal-oil, he calls it

"coal-oil charged with alizarine." Again the term alizarine, in the same general, and, as we may say, loose sense, is used to indicate still cruder preparations, as for example in Dingler's Polytechnisches Journal, vol. 216, page 451, we have as follows, in a foot note: "It is to be noticed that this Pinkoffin is more frequently in England as well as in France brought into commerce under the name of purpurine. This name designates just the opposite of what the article really represents; it should rather be called alizarine." And again in Schützenberger, vol. 2, pages 151 and 152, we have as follows: "*Alizarine* (G. Schaeffer) commercial or Pinkoffin—Messrs. Pinkoff, Schunck & Co., of Manchester, introduced into the market during 1854 a variety of garacine known by the name of commercial alizarine. This product presents itself in the shape of a fine powder, of a chocolate color." In fact I think it is entirely beyond question that the word is used throughout the literature of this subject in the same general way that the term iron is used, when we say an iron bridge, and iron building, iron ore, iron salts, or speak of administering iron in medicine, namely, where the idea conveyed is that iron in some condition is present as an available constituent, but by no means implying that even in the opinion of the writer, still less as a matter of fact, it is in a pure condition or the only efficient element present for the purpose or use involved.

Q. 7. In the foregoing answer you have described certain meanings which have been attached by standard authors to the word alizarine. Please explain what is the origin or history of that word and of its various significations?

A. The word alizarine was first introduced into the literature of chemistry in 1827, when in an article entitled "New researches on the coloring matter of madder," by Messrs. Colin and Robi-
67 quet, read before the French Academy of Sciences on the 6th of November, 1826, and published in the "Annales de Chimie et de Physique," vol. 34, we find on page 240, in reference to crystals of what we may call pure alizarine, obtained from madder by a simple process of washing out and sublimation or of solution with either, the following remark:

"We propose to name them (*i. e.* the crystals) alizarine, which we take from the word ali-zari, used generally on the Levant, and which is now established in commerce to designate the entire madder root."

This material was, however, never applied successfully as a dyestuff, on account, as we now have every reason to believe, of the absence of purpurine, as well as of other matters which probably exercise a beneficial influence in the dye-bath.

It was, nevertheless, supposed not only by Colin and Robiquet, but by many authors down almost to the present time, that this crystalline body which they had obtained was the only efficient dyestuff contained in madder or its extracts. In consequence of this arose the practice of calling any preparation of madder by the name alizarine, just as we would call all sorts of wines, brandies, beers

and the like alcoholic beverages, if we believe the alcohol to be their only efficient constituent.

Thus, as various processes were devised for preparing what may be properly called madder extracts, that is, extracts obtained from madder root, and containing, as was supposed, simply alizarine in a state of greater or less purity, these were naturally called alizarines, but we now know that their efficiency as dyestuffs actually depended upon the presence in them of other dyeing matters besides alizarine, yet they may still without impropriety be designated alizarines, since this word, by its derivation, really includes the entire material of the madder root, although in works of pure chemistry the word may be set apart and assigned exclusively to the pure chrystallizable substance whose formula is C_{14} H_8 O_4.

When Graebe and Liebermann had produced, not as an extract from anything, but built up by an entirely new chemical process of construction from crude elements, a body which they found to be a good substitute as a dyestuff to the existing madder extracts, they also called it alizarine.

Q. 8. What authority have you for the statement that Graebe and Liebermann considered their artificial alizarine as a substitute for the existing madder extracts?

A. On the 27th of January, 1869, Gustav Schaeffer read before the "Societé Industrielle," at Mulhouse (which is, as its name implies, not so much a purely scientific body as an industrial one, being largely composed of manufacturers of various kinds, including calico printers), extracts from a letter received from Liebermann, in which occur the following expressions: "I am able to confirm the truth of the news which you have received in regard to artificial alizarine. After a year of work, and after having indicated
68 theoretically the results which we wish to obtain, we have at last prepared artificial alizarine, which, by dyeing, gives the same results as madder."

This appears in the bulletin of the above-named society, 1869, page 46.

Q. 9. What are the characteristic results obtained by dyeing with madder?

A. With a strong alumina mordant it yields a rich red, and with a light alumina mordant, a pink; with a weak iron mordant, a violet, and with a strong iron mordant, a black. The reds and pinks, however, are the colors universally recognized as characteristic of madder colors.

Q. 10. What do you understand to have been the meaning of Liebermann when he states in the extract you have just quoted that artificial alizarine by dyeing gives the same results as madder?

A. I think the words themselves very clearly express that he found the artificial alizarine when used with alumina mordants yielded reds and pinks, and with iron mordants, violets and blacks, similar in appearance to those he obtained with madder.

Q. 11. Referring to complainants' patent, reissue No. 4321, please

state whether or not, in your opinion, any person skilled in the art or science to which it relates would be enabled, by following the description therein, to make and use the invention described and claimed in that patent.

A. They would.

Q. 12. Have you manufactured the article described and claimed in said patent called therein artificial alizarine by the methods set forth in it?

A. I have, a great number of times.

Q. 13. Please produce some of the artificial alizarine so manufactured by you, and please state when the same was made.

A. I produce some; it was manufactured by me some time last month.

(Counsel for complainant offers in evidence the phial and contents just produced by Prof. Morton, and the same is marked "Complainant's Exhibit Morton No. 1.")

Q. 14. Would or would not, in your opinion, any difficulty be found in practically carrying out and applying to use in the arts the invention described and claimed in complainant's patent by the means or processs set forth in it?

A. There would be no difficulty; being obliged to work on small quantities at a time, there have been made in my laboratory at least as many as fifty batches of artificial alizarine, and, I think, without a single failure.

69 Q. 16. Have you examined any of the contents of the bottle, "Artificial Alizarine, Exhibit Browne, No. 1."—J. G. S., examiner, for the purpose of ascertaining what those contents are; and if yea, what do you find the same to be?

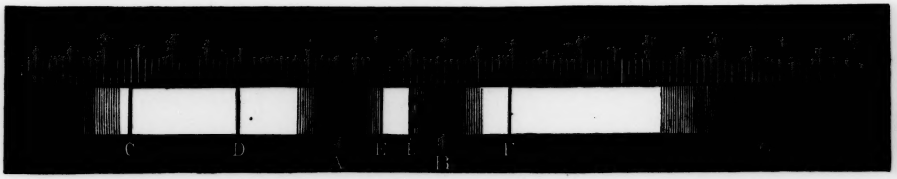
A. I have examined it, applying numerous tests, and find it to be the artificial alizarine described in complainant's patent.

Q. 17. Have you examined the artificial alizarine of complainant's patent and also extracts of madder, with a view of determining as far as possible the exact constitution of each, and the efficiency as dyeing elements of their various constituents if such were found to exist in them? If you have done so, please state the results of your examination.

A. As I have already stated in a previous answer, I have made careful separations of madder preparations, or, as they may be well described, commercial alizarine, into its principal constituents, and have also made a similar separation of artificial alizarine, the subject of complainant's patent; I find that commercial alizarine as found, for example, in Pincoffin, green alizarine and yellow alizarine, consists essentially of two available dyestuffs, one of them being the pure alizarine, whose formula is assumed to be $C_{14} H_8 O_4$; and purpurine, whose formula is assumed to be $C_{14} H_8 O_5$; the first of these substances I believe that I have obtained in a pure state, by following out a process described by Rosenstiehl, involving, among other things, the heating of the substance—commercial alizarine—for about ten hours in a steam boiler, under a pressure of 250 pounds to

the square inch, subsequent solutions, crystallization, and sublimation; when so prepared the body presents all the characteristics ascribed to pure alizarine, but when used as a dyestuff it fails entirely to give good reds and pinks, and as these are the colors which are the most valuable and characteristic tints produced by madder extracts or commercial alizarines, this body is evidently not a commercial substitute for or equivalent of such madder extracts.

In the second place I find that the madder extracts contain, as I have said, purpurine, which likewise, by prolonged treatment founded on the processes described by Schutzenberger and others, I have obtained in a condition of purity; it then agrees in its properties with the description given by standard authors of this substance, and with alumina mordants produces very brilliant scarlet and orange pink colors; this substance purpurine has besides two optical properties very valuable as affording means for its recognition; when dissolved in a strong solution of alum it gives an orange red liquid, which fluoresces strongly with a rich green color; this property was first noticed by Prof. Stokes, and is manifest in this way: If a tube or bottle containing such solution is looked at from the side on which the daylight strikes it, it will appear opaque and of a green color; while, seen from the other side, it appears perfectly transparent and of an orange red color; Exhibit Morton No. 2 is such a solution of purpurine in water containing alum. The second optical property is the following: If the light, transmitted through a solution of purpurine in alum water as above, is viewed through a spectroscope, the spectrum or strip of graduated colors is seen to be crossed by two dark shaded bands, located as shown in the drawing Exhibit 3:



(The woodcut made from Exhibit 3, here introduced, represents the appearance and position of the absorption bands A and B, above referred to. The scale at the upper part of the figure is that introduced by Bunsen and Kirchhoff, for purposes of comparison. The long horizontal band represents the spectrum, colored red to the left, and so passing through crimson at C, orange at D, then yellow, then green, extending each side of E and *b*, then blue at about F, and then blending into indigo and violet toward the right. The sharp vertical lines C, D, E, *b*, F and G, are known as Fraunhofer lines and belong to the sunlight by which the spectrum is produced. Were the solution of purpurine not present the broad bands marked

A and B would be absent, but the others would still remain. These Fraunhofer lines are perfectly fixed in position, and are very valuable as means and standards of measurement.)

(Counsel for compl't offers in evidence the purpurine solution and the drawing referred to by the witness, and the same are marked respectively "Exhibit Morton No. 2," and "Exhibit Drawing No. 3.")

The witness continues:

A, B, on said drawing, indicate the positions and character of these bands. No such bands under the conditions named are produced by alizarine or any of the other substances, other than purpurine, found in madder extracts, nor are any such bands produced by artificial alizarine as a whole or by any of the different bodies into which I have separated it. I now introduce a bottle containing a solution of purpurine in water containing alum, sufficiently dilute to show these bands with a common pocket spectroscope. This bottle is marked Complainant's Exhibit Morton No. 4.

I also introduce a similar solution made by treating commercial green alizarine with alum water, and this is marked Exhibit Morton No. 5. I also introduce a similar solution from commercial yellow alizarine. This is marked Exhibit Morton No. 6. All of these show the absorption bands above described equally well.

71 I also introduce a specimen of the purified purpurine prepared by me, as hereinbefore described, and crystallized by sublimation, marked Exhibit Morton No. 7; and lastly, for comparison with the above, a specimen of the chemically pure alizarine, also prepared by me and crystallized by sublimation, marked Exhibit Morton No. 8.

(Counsel for complainant offers in evidence the several exhibits referred to by the witness, and the same are marked respectively Compl't's Exhibit Morton Nos. 4, 5, 6 and 8.)

Passing now to the comparison of the artificial alizarine, the subject of complainant's patent, I have examined it in the methods described by Perkin in the Journal of the Chemical Society—London, 1873, vol. 26, page 425, and also by the methods of Auerbach, published by Kopp in the Moniteur Scientifique, 1872, page 686.

By such treatment I find in it—1st. Anthrapurpurine, a body first isolated by W. H. Perkin, as stated above, and named by him anthrapurpurine; 2d. Isopurpurine, a body first isolated by Auerbach, as stated above, and named by him isopurpurine. These moreover are present not as slight traces or insignificant impurities, but in large proportions, varying from 30 to 60 per cent. It is my belief that to their presence the artificial alizarine owes it efficiency as a dyestuff. By a proper regulation of temperature and the amount of soda or potash their proportion in the material may be so increased as to render it a scarlet rather than a crimson dye, and this fact adds greatly to the value of the artificial alizarine for many purposes.

Q. 18. To what do you refer in your last answer, where you say that by a proper regulation of temperature and the amount of soda or potash, the proportion of anthrapurpurine and isopurpurine in artificial alizarine may be increased?

A. I have been informed that in the manufacture of artificial alizarine on the large scale, those grades of artificial alizarine which give the more scarlet shades and which are found to contain the largest proportion of these bodies are produced at the higher temperature and with the larger quantities of the alkalies, and I have found a similar result to follow in my own experiments. The patent of complainants giving only general directions that the temperature is to be between 180° and 260° centigrade, I experimented at various temperatures between these two, with amounts of alkalies varying from two to three times the weight of the bibromanthrachinone, as directed in the patent, with the results above described.

Q. 19. Did you find any other substance besides those you have mentioned in artificial alizarine?

A. I found a yellow material corresponding in its behavior with that which has been named, in accordance with the chemical
72 theory of its constitution, monoxanthrachinone. It is separated from the artificial alizarine by converting the whole into a lime lake and washing with hot water, which removes the substance as a reddish solution from which hydrochloric acid precipitates it as a yellowish powder. Artificial alizarine, according to various authors, contains a number of other products in various quantities, but I have not attempted to separate them.

Q. 20. Are these substances which you have mentioned as existing in artificial alizarine, namely, anthrapurpurine, isopurpurine and monoxanthrachinone, found in madder or in any of its preparations, or in any other dye-stuffs, excepting in artificial alizarine?

A. They are not found; although madder, which is the likeliest substance to contain them, has been elaborately studied by the ablest chemists for many years. It is, indeed, my opinion that no such bodies existed until they were produced by Graebe and Liebermann, by their process described in complainant's patent.

Q. 21. Are these substances which you have isolated from artificial alizarine, namely, anthrapurpurine, isopurpurine and monoxanthrachinone, the only ones contained in it?

A. They are not. There are contained in it in addition:

1st. Pure alizarine, whose presence in it was first recognized by Graebe and Liebermann, and which was first described by them in the Proceedings of the German Chemical Society of Berlin, 1869, page 14, and also further discussed in a subsequent paper published in the same volume, pages 232, 234.

2d. Anthraflavic acid, first isolated by Edward Schunck, and described by him in the Chemical News, April 6, 1871, vol. 23, p. 157.

3d. Also, an orange-dyeing matter, first noticed by Perkin, and

mentioned by him in his paper, in the Journal of the Chemical Society, London, 1873, p. 425.

4th. There are also present other substances, whose action in the dye-bath has not yet been studied.

5th. And, finally, we find as impurities, properly so called, small quantities of anthracene, anthrachinone, and traces of mineral matter.

Q. 22. You have stated that the presence of pure alizarine in the artificial alizarine was first recognized by Graebe and Liebermann; please state fully what you understand to be the nature of their recognition of this substance at that time, and the history of the subsequent investigation of this substance and of artificial alizarine by them and by other chemists?

A. The artificial production of a substitute for madder as a dyestuff had been for many years a subject of investigation on the part of many eminent chemists, among whom we may name Laurent, Martius and Griess, and others.

In course of his investigations of a class of bodies known as the chinones (remarkable for their tendency to produce derivatives having tinctorial properties), Graebe extended the range
73 of bodies coming within that class from the benzole derivatives into the derivatives of naphthaline and toluol, and after this, together with Liebermann, he was led to believe that alizarine belonged to the chinone series. To test this idea they sought to reduce alizarine so as if possible to find out to what radical it was related. By heating it with zinc dust they obtained a body possessing all the properties of anthracene, and were thus led to the conclusion that it was a chinone derivative belonging to this radical. Having thus obtained a knowledge, never before possessed, of the chemical structure and relations of alizarine, they were stimulated to attempt what had been so often essayed in vain, namely, the artificial construction of this body. It should be here remarked that Colin and Robiquet had isolated from madder one of its dyeing elements, which they, and most chemists for a long time after them, believed to be the only important dyeing element in madder, and to this they gave the name alizarine. By a series of processes, Graebe and Liebermann obtained a complex product in the form of a paste, *from which, by sublimation*, they obtained a crystalline material corresponding essentially in its general properties with the alizarine obtained from madder by Colin and Robiquet. In a chemical point of view this was the crowning triumph of their labor. They had discovered the true chemical relationship of alizarine, and had reproduced it by artificial means. To confirm and establish this discovery as a fact in chemistry, they made analyses of the sublimed crystalline extract from their product and of a similar sublimed extract from madder, and obtained results according, within the usual limits of such work, and similarly agreeing with their theoretical formula as to the constitution of the extracted bodies. We now know that the methods pursued by them for purifying both these

extracts were by no means perfect, and that their extract from their new body must have contained, anthrapurpurine, isopurpurine, anthrachinone, and monoxanthrachinone, though by their methods (i. e., extraction by sublimation) the greater part of these substances is destroyed, as also more or less alizarine. The presence of the first two would tend to make the analysis show a deficiency of hydrogen and carbon, while the presence of the last two would develop an excess of these. This tendency to balance would therefore keep the results within the usual limits of error, even if very appreciable quantities of all were present. As soon as this new dye-stuff began to be manufactured, and came into the hands of chemists at large, it began to be investigated, and, one after another, various bodies which it contained were recognized. These researches were made by Perkin, Auerbach, Graebe and Liebermann themselves, Schunck, Koechlin, Rosenstiehl and others, and have so far resulted in the discovery and separation of the various definite compounds, such as isopurpurine, anthrapurpurine, etc., which I have already mentioned. The subject is, moreover, by no means exhausted at the present time, for we find in the "Berichte der Deutschen
74 Chemischen Geselschaft zu Berlin," for 1876, a discussion going on between Messrs. E. Ulrich and H. von Perger on the one hand and E. Schunck and H. Roemer on the other as to priority in discovery of two new substances which they have found in the artificial alizarine of Graebe and Liebermann.

Q. 23. Is the sublimed crystalline body, mentioned in your last answer, described or mentioned in Graebe and Liebermann's patent, either in their original patent or their reissue No. 4321?

A. It is not. On referring to their original patent, No. 95,465, we find as follows: "We collect the yellow flocks of alizarine, thus obtained, on a filter, and wash them with water. By these methods we receive the alizarine in a form in which it can be employed, in the same manner as the different preparations from madder."

It is worthy of note that they here expressly stop the description of their process at the point where the entire product of the reaction is present, and where, consequently, it is, as they say, in a state "in which it can be employed in the same manner as the different preparations of madder." In order that they should have described the crystalline sublimed extract, which they supposed to be identical with the madder alizarine of Robiquet and Colin, it would evidently have been necessary for them to have stated further that the yellow flocks, after being washed, were to be dried and then sublimed. It is a matter which cannot escape the notice of any one experimenting with artificial alizarine, that even by merely drying the product at the boiling point of water, its effects as a dye-stuff is modified in a very marked degree. It is for this reason that from the first it has never been put into the market otherwise than as a paste, and the sublimation, requiring a far higher temperature, produces a still more marked change. That Graebe and Liebermann were aware of this is perfectly evident from the expressions in their patent above quoted,

and it thus appears that they intended to designate, by this expression, the entire product of their process, which was an available substitute for madder, and not that single element of its composition which was chiefly interesting from the point of view of theoretical chemistry.

Q. 24. Having reference to the investigations described by you in answer to question seventeen, please state to what conclusions they lead yon as to the similarity or dissimilarity of the artificial alizarine of complainant's patent, and madder extracts or preparations; please give your reasons for your conclusions.

A. The result of these experiments is to convince me that while madder extracts or commercial alizarines and artificial alizarine contain as one of their constituents a body such as I have described under the name of pure alizarine, which may very probably be identical in all of them, yet this by no means constitutes their only or chief efficiency as practical dye-stuffs, but if alone would be worthless in the most important cases, and that while madder and its preparations owe their practical value to the coexistence in their composition of purpurine, which has been proved to be an essential element, and various other materials, whose effects in the dye bath has not yet been fully investigated, the artificial alizarine owes its efficiency to the coexistence in its composition of anthrapurpurine and isopurpurine, and this is no insignificant quantity, but as a large constituent, not to mention monoxanthrachinone, anthraflavic acid, and Perkin's orange matter and other substances, whose influence in the dye bath has not yet been settled, though there can be no doubt that such an influence exists, and is practically important.

Q. 25. What is alizarine, in the sense in which that word is used in the patent of complainants?

A. Having reference to the word in connection with the preliminary directions of the patent, I should say that it implies a substance produced by the process described therein—that is to say, built up, as it were, from compounds less complex than itself by chemical reactions, involving none of the peculiar processes characteristic of animal or vegetable life, but capable of replacing as a dye-stuff the ordinary alizarines or madder extracts.

Q. 26. Could the description of the invention in complainant's patent be understood as applying to or embracing the production of a substance already known at the time they made the invention?

A. It could not. It describes a process which I have repeatedly carried out with the production of a product containing, as essential constituents, substances which I do not believe to have existed, and which were certainly unknown prior to this invention; and it is to the presence of these substances that the new product owes its practical efficiency and value as a dye-stuff.

Q. 27. Having in view the state of the art at the time of the grant in this country of letters patent to Graebe and Liebermann for this

invention, do you regard their description of their product as correct?

A. I do. These inventors had made an essentially new dye-stuff, which they found to be an efficient substitute for preparations of madder, and capable of taking their place in the ordinary operations of dyeing and calico printing.

The body described, being a new composition of matter, whose properties, with the exception of its action as a dye-stuff, had been only partially investigated. It was best defined as being the product of a process which, as we have seen, cannot fail to produce the new substance, which is the subject of this patent. It was not until several years spent in investigation by the ablest chemists that the true composition of this new dye-stuff was even partially recognized, and even at the present time the subject is far from being exhausted.

76 Q. 28. Do you consider the alizarine described in the patent to be the same thing as the pure alizarine whose formula is $C_{14} H_8 O_4$?

A. Certainly not; it cannot be represented by any formula. As I have already said in previous answers, the artificial alizarine of complainant's patent contains, besides pure alizarine, large and practically essential quantities of other dyeing matters, such as anthrapurpurine and isopurpurine, to say nothing of monoxanthrachinone and several other substances whose practical relations in the dye-bath are not yet well understood.

Q. 29. Are your statements in previous answers, as to the composition of artificial alizarine, supported by the publications of standard authorities, and if so, please quote some of these corroborative publications?

A. My statements are, I believe, fully confirmed by the highest authorities, as I will now show.

The first to separate out or isolate anthrapurpurine was the well-known English chemist, W. H. Perkin. In 1870, even while he was still under the impression that the pure alizarine was the only efficient dyestuff in madder, he nevertheless states (see Journal of the Chemical Society of London, 1870, vol. 23, page 143): "Artificial alizarine, as supplied to the dyer and printer, is not chemically pure, and usually produces, with alumina mordants, colors somewhat redder than madder. It has been stated that this is due to the presence of purpurine; this, however, is not the case, as none of this coloring matter can be detected even by Prof. Stoke's test (the fluorescent appearance)." Dr. Schunck has also confirmed this.

"The shade of color produced with artificial alizarine may be modified to some extent by regulating the temperature of the dye-bath, the colors of the alumina mordants being nearer to those produced with madder, when a low temperature is employed The redder shade produced with this coloring matter is, however, often preferred, especially for turkey-red dyeing. The quality of the coloring matter

appears to be under the control of the manufacturer to a considerable extent, and it is possible that eventually artificial alizarine will be prepared in a nearly chemically pure state."

In a foot-note to the above, Perkin remarks: "When purifying artificial alizarine by converting it into an alumina lake, I found that upon digestion with carbonate of potash this lake gave a red-colored solution containing a coloring matter, dyeing mordants very similarly to alizarine, with this difference, that the reds are more scarlet and the purples bluer or more slaty. I have not obtained this body in a perfectly pure state as yet, but it appears to be crystalline."

We have here a publication of the first partial separation of anthrapurpurine from the product of Graebe and Liebermann.

In 1872, in vol. 25 of the same journal, on page 659, he 77 gives an analysis of the same substance and a formula C_{14} H_8 O_5; and furthermore says: "This formula is the same as that usually assigned to purpurine. The substance is, however, entirely different in properties from that coloring matter; for example, its etherial solution does not give the characteristic bands when examined with a spectroscope, nor does it form the pink fluorescent solution when boiled with a solution of alum. It also dissolves in alkalies, with a violet color, not a red.

"It also differs from alizarine in many ways. Its solution in caustic potash is not of such a blue violet, although it gives two bands, when viewed with the prism, similar to those of alizarine, but not so marked. It dissolves in ammonia with a red purple color, and this solution gives no bands, whereas alizarine dissolves with a blue violet color, and gives two bands. Its ammoniacal solution, when added to aluminate of potash, produces no precipitate; an ammoniacal solution of alizarine gives a red lake usually at once, but always after standing for some time.

"This coloring matter is, therefore, distinct, both from alizarine and from purpurine."

In 1873 he had completed his examination and numerous analyses of the substance, and in volume 26 of the same journal, page 425 et seq., he publishes a complete discussion of the new substance, for which he proposes the name anthrapurpurine. Attached to this paper are specimens of calico dyed with anthrapurpurine, and with pure alizarine. On page 425 he says as follows:

"Commercial artificial alizarine when introduced as a dyeing agent was generally supposed to contain purpurine, owing to the pureness of the red colors it produced with alumina mordants; but in a paper which I had the honor of reading before the society some time since, this idea was shown to be incorrect. In the same paper, however, the existence in this product of a coloring matter differing from alizarine was pointed out. I have been for some time experimenting with this substance, and in August last brought a short account of it before the society; I now beg leave to give a more detailed account of the results I have obtained in its examination.

"To obtain this substance, which I propose to call anthrapurpu-

rine, from commercial artificial alizarine, I have tried various methods. * * * * * The anthrapurpurine thus obtained is very impure, being associated with a substance dyeing alumina mordant of an orange color,* as well as anthraflavic acid," etc. On page 433 he says as follows:

"*Anthrapurpurine as a Dyeing Agent.*

"This substance has about the same affinity for mordants as alizarine. The colors it produces are also analogous to some
78 extent, as it produces red with alumina, purple and black with iron mordants. There is, however, a considerable difference in the shade of color produced, the reds being much purer and less blue than those of alizarine, whilst the purples are bluer and the blacks more intense. The fastness of the colors against soap and light are quite equal to those produced with alizarine. When used to dye turkey red, it produces very brilliant colors of a scarlet shade, which are of remarkable permanence.

"The patterns attached to this paper are only amateur productions; if dyed on the large scale, the colors would probably be purer, but they serve to illustrate the difference between the shade of color produced with anthrapurpurine and pure alizarine."

In 1872, in the Moniteur Scientifique, pages 686 and 687, I find an abstract by E. Kopp, of a research by Auerbach, entitled "Sur l'isopurpurine produit extrait de l'azarine artificielle," in which he gives a full account of the method by which he separated from artificial alizarine a substance resembling purpurine, although entirely different from in it many important particulars. On page 687 he says:

"On mordanted cotton, isopurpurine gives tints resembling those of purpurine; the reds and pinks approach scarlet; the violet is brownish; the browns and blacks are strong. These colors resist boiling soap well. The small portion of the baryta lake which is not dissolved in water, having been decomposed by hydrochloric acid, we can isolate from it a coloring material which presents all the properties of alazarine, properly so called. By a sufficiently large number of reactions isopurpurine differs from purpurine, and these two substances cannot be considered as identical. The fact of the artificial production of a coloring material having the same composition, and most of the tinctorial properties of purpurine, is not only very important from the practical point of view, but also very interesting from that of theory."

Again, in the "Handbuch der Chm. Technologie," by Dr. P. A. Bolley and Dr. H. Birnbaum, 1874, vol. 3, page 409, in an article entitled "A Treatise on the Artificial Production of Organic Dyestuffs," by Dr. E. Kopp, we have as follows:

"*Methods for the Production of Artificial Alizarine.*

"The history of these methods for producing shows most clearly how the most difficult and expensive reactions applied at first, were

"*This is under investigation."

gradually simplified, and how, step by step, the very expensive reagents were substituted by cheaper ones, without impairing in the least the good quality and purity of the product." Again on pages 418 and 419, we have as follows under the title:

"'Properties of the Artificial Alizarine.'—The manufac-
79 ture has made such progress that the principal manufacturers can supply at this time several varieties of artificial alizarine according to demand; for instance, Gessert, at Eberfeld, supplies alizarine of yellow shade and alizarine of blue shade. The alizarine yellow shade is principally used for dyeing and printing reds. On account of the purity of this dyestuff, the colors yielded by it are also immediately clear, and after a slight soaping they far surpass in brilliancy the colors produced with madder and garancine. The yellowish tinge, while shading the color a little scarlet, enhances the beauty of the red. The alazarine bluish shade is used in producing violets and lilacs, and replaces favorably madder flower and Pinkoffin.

"Dyeing tests made with dry alizarine and with alizarine in paste, corresponding exactly in amount of dry coloring matter, have shown a considerably smaller yield of color, with the dry product."

On page 534 we find as follows: "That artificial alizarine may contain a larger number of compounds than one was formerly disposed to accept, is proved by the presence of anthrapurpurine isolated by Perkin, besides oxanthrachinone, anthraflavone, isopurpurine, &c."

And on page 535 we find as follows: "Anthrapurpurine dyes the various mordants for the same colors as easily and fast as alizarine. But the shades are different, the reds are more brilliant and purer, being less bluish; the lilacs are more blue, and the blacks much fuller and more intense.

"On cloth prepared for turkey-red, the anthrapurpurine yields a brilliant, very solid (fast) scarlet red."

In the report of the Vienna Exhibition of 1873, p. 26, by Graebe and Liebermann, I find as follows:

"As has already been stated in the introduction, there is always produced in the fusion of the anthrachinone sulpho-acids with caustic soda, besides alizarine, a dyestuff having the same composition as purpurine in greater or less quantities. As a consequence of this, it is also contained in varying quantities in commercial alizarine; in the smallest quantity, in the alizarine for violets, most abundantly in the alizarine for red. It cannot be called a bi-product, because for the production of certain red shades it has advantages even over alizarine."

In the "Moniteur Scientifique" for 1869, on pages 874 and 875, I find a letter to the editor of the above journal from M. Camille Koechlin, of Mulhouse, which I translate as follows: "I have the satisfaction to announce to you that the artificial alizarine which you have sent me has yielded on trial colors superior to those of madder and to its commercial derivatives. These colors exhibit new qualities. They differ from those of purpurine, and fortunately have nothing in

common with those of alizarine. The reds are more scarlet'
80 the chocolates are richer, the iron mordants are better dyed.

It is madder under a new constitution, uniting at once and in a marvelous manner the qualities of alizarine with those of purpurine; with one exception only, in reference to the pinks which incline to yellowish, a question of perfection for the developing of alizarine.

"Although this synthetic rival which comes from the factory of Messrs. Meister-Lucius, is not for sciences, the alizarine of the alizaris, a coloring matter which is produced at a low temperature; it is for industry infinitely more than that alizarine; it is the madder of the future, and by general consent it is the solution of the problem of Laurent. The alizarine, or rather the artificial madder of Meister-Lucius, is in the state of a paste which represents five times the tinctorial power of madder. By sublimation it yields needles shorter and paler than those of alizarine, and which give with the alkaline reagents the coloration proper to purpurine, while at the same time it is not purpurine."

On page 914 of the same volume I find a series of specimens or swatches illustrating the comparative tinctorial properties of certain dyestuffs which are described on the back of the same leaf or page 913 as follows:

"Colors of strong tint obtained for comparison with the following coloring matters: 1, artificial alizarine of Messrs. Meister-Lucius & Co., at Hoechst, near Francfort; 2, madder; 3, garancine; 4, natural alizarine sublimed; 5, purpurpine sublimed. For the information of those who are not familiar with the processes of dyeing, we state how the five different tints which are seen on each strip of the colored materials 1, 2, 3, 4, 5 are obtained. Eeah band, except the little separation which has remained white, is mordanted in a cylinder *ad hoc*. The first color which is found at the bottom of the page and which is black, by a concentrated solution of iron; the second color following upwards by a solution of alumina and of iron concentrated; the third with a concentrated solution of alumina; the fourth with a dilute solution of alumina, and the fifth with a diluted solution of iron.

"The strip of cotton thus prepared is placed in the dye-bath from 45 to 100 degrees, and the five colors are developed.

"Passed thereupon into a bath of boiling soap the mordanted parts are cleared, and the parts not mordanted, the little white bands of which we have spoken, become colorless, madder having no affinity for cloth which is not mordanted."

Continuing on page 915 we read: "These irrefragable witnesses declare that artificial alazirine is neither alizarine nor purpurine, but a new compound superior for our purposes to the derivatives of madder. Although these are thus menaced with a speedy end and have given cause during their existence to more researches and publications than any other coloring matter, I will, nevertheless, review

81 some of the characteristics of the coloring matters of the Rubiaceæ.

"The coloring matter of the madder colors is a mixture: 1, of alizarine and purpurine in varying proportions according to the cultivation and to the species of salts, whose assimilation this cultivation has favored. Where the soil is calcarious one part of the coloring matter, sometimes more than half, is united with the lime, and this part destroyed for dyeing purposes is first taken from the purpurine. For this reason those madders are richest in purpurine which are cultivated in the ground containing least lime. The madder containing most purpurine yields orange shades, while the madder in which purpurine is held latent by a base, dyes more of a carmine color on account of the alizarine. Purpurine is a stronger acid than alizarine; it displaces it from its combinations and even prevents it from dyeing if present in sufficient quantities. On its part, purpurine does not give fast colors unless it is associated with alizarine or has been sublimed or exposed to a temperature of 200° C, a temperature which is not far removed from that at which artificial alizarine is produced. Purpurine alone does not resist boiling soap, while alizarine alone or alizarine with purpurine do resist."

In a recent work entitled "A Manual of Dyeing and Dyeing Receipts," by James Napier, London, 1875, I find as follows on pages 335 and 336:

"Wherever the artificial colors can be produced and sold to the dyer at a price lower than the natural, the latter must yield. Notwithstanding this, artificial alizarine will not put madder quite out of the market; for the latter is preferable for many colors upon wool, because it contains other dyes which the wool takes up, giving tints which pure alizarine does not, but further discoveries may soon overcome this difference. The reader will have seen that mauve and magenta were only the first of a series of new dyes, so also may alizarine yet turn out to be; and should there develop from this source a series of colors with the permanency of alizarine, the result will be of the greatest importance to the dyeing and calico printing trades. Indeed, we have already indications of such a series. Mr. Perkins has announced that when experimenting upon alizarine, he found that there was produced along with that coloring matter, another which gave certain reactions differing from alizarine; it gave with the same mordants a bluer purple and a more scarlet red; and to this coloring matter he has given the name of anthrapurpurine, and its formula is $C_{14} H_8 O_5$. He separated this anthrapurpurine from crude (artificial) alizarine by dissolving the latter in a dilute solution of carbonate of soda, and adding precipitated alumina, which on agitation combined with the alizarine, forming a lake which precipitated and left the anthrapurpurine in solution; he boiled this clear solution and acidified with hydrochloric acid, which caused the coloring matter to be precipitated. Mr. Perkin
82 says this coloring matter is still associated with another which gives an orange color with aluminous mordants. By repeated

boiling in alcohol this orange coloring can be removed from the anthrapurpurine. These processes of separation are yet difficult but hopeful; the orange coloring matter has not yet been subjected to analysis. The following are some of the properties and reactions of anthrapurpurine; it is very slightly soluble in water; caustic potash and soda dissolve it, giving beautiful violet-colored solutions, which become blue when heated, but not so blue as those obtained with alizarine; it dissolves also in solutions of the alkaline carbonates, giving a reddish purple color, which is precipitated with carbonic acid. If a solution of it in alcohol have acetate of copper added the color changes from a yellow to a beautiful purple. When an ammoniacal solution of it is acidified with hydrochloric acid the dye is precipitated as a dark purple, which dissolves in carbonate of soda, yielding a blue color, and in caustic alkalies yielding a reddish purple. Mr. Perkin says that anthrapurpurine has about the same affinity for mordants as alizarine; the colors it produces are also to some extent analogous, for it dyes red with alumina, purple and black with iron mordants. There is, however, he observes, a considerable difference in the shade of color produced, the reds being much purer and less blue than those of alizarine, and the purples, blues, and blacks more intense. The fastness of the colors against light and soap is equal to that of the alizarine colors. When used in dyeing turkey-red it produces very brilliant colors of a scarlet shade, which are remarkable for their permanence."

Again, in the second supplement of Watts' Dictionary of Chemistry of 1875, on page 41, I find as follows:

"Red color printing with artificial alizarine.—A. Muller (Chem. Centralblatt, 1871, 304,) obtains a red similar in tint and purity to turkey-red, from anthracene-alizarine by a process of direct printing.

"The pigment (containing much anthrapurpurine) in a pasty form, and having 25 per cent. of dry material, is dissolved in boiling spirits, etc."

On page 89 of the same work we find as follows: "As a dying agent anthrapurpurine has about the same affinity for mordants as alizarine. The colors it produces are also analogous to some extent, as it produces red with alumina, purple and black with iron mordants. There is, however, a considerable difference in the shade of color produced, the reds being much purer and less blue than those of alizarine, whilst the purples are bluer and the blacks more intense. In fastness against soap and light the colors are quite equal to those produced with alizarine."

Indeed, it seems to me impossible that any question on this subject can be seriously entertained when the most important researches in connection with this subject are those which have developed
83 the existence and properties of such important coloring principles as anthrapurpurine and isopurpurine. Before these researches were made it was, of course, natural for writers who did not as yet know of the existence of these bodies, and were not even led to suspect their existence through want of practical acquaintance

with the behavior of the artificial alizarine as a dyestuff, to describe the one material which they had recognized; but of course such a description and expression counts for nothing against their own subsequent testimony or that of others, when these substances, anthrapurpurine and isopurpurine, had been recognized in it, separated and experimented with.

Q. 30. You have stated in previous answers that chemically pure alizarine indicated by the formula $C_{14} H_8 O_4$ is not a practically available dyestuff, similar in its effects to the commercial extracts of madder, this opinion being founded on your own experiments; will you state what support for this opinion you find in the publications of standard authors?

A. As early as 1853, in the work entitled "A Manual of the Art of Dyeing," by James Napier, F.C.S., Glasgow, 1853, I find the following:

"From the above reactions of alizarine with other substances it was supposed that it constituted the true coloring of madder, and means were soon adopted to separate this coloring matter from the vegetable and use it pure; but it was afterwards found that a fixed dye could not be obtained by pure alizarine, and, therefore, it did not constitute all that was required in giving the dye. This led to further investigations productive of further discoveries respecting these coloring matters. It finally appeared that madder has five different coloring matters, which have been named madder purple, madder red, madder orange, madder yellow, madder brown; each of which may be obtained by the following operations." Here follows a description directing how the substances named above may be obtained, though evidently each of them in a very impure condition.

This view, as to the composition of an available madder dye, though at the early date of its first publication by no means universally accepted, has been in all essential particulars fully confirmed by the many elaborate investigations which have been made by different chemists during the 22 years which have elapsed since this book was published; and in the very latest edition of the same work, entitled "A Manual of Dyeing and Dyeing Receipts," by James Napier, P.R.S.E., F.C.S., etc., London, 1875, we have repeated, on page 289, precisely the same statement, with a single unimportant verbal modification. Among the authors who have elaborately investigated this question is Schutzenberger, who, in the "Moniteur Scientifique" for 1869, in an article on "*The application of Madder Extracts in Calico Printing, and the part played by the different Pigments of Madder*," says:

84 "Pure alizarine gives very beautiful violets, but the reds are too violet. The fine reds are only obtainable with extracts containing at the same time alizarine, purpurine, and even a certain proportion of the yellow matter, mixed in the proper proportions. On the other hand these extracts only give dull violets.

"Here is revealed in a very clear manner the influence of the various madder pigments of which we have yet to speak. In the

actual state of the science and according to the researches of a great number of chemists, it must be admitted that the pigments of madder, little or not at all soluble in water, pre-exist in the fresh root in the form of glucosides, soluble and easily decomposed by ferments, by acids, and by alkalies. The coloring matters separated from their glucosides and whose existence seems to us at the present time placed beyond doubt, are—

"*First*—Alizarine, discovered by Robiquet and Colin.

"*Second*—Purpurine, studied by Persoz, Runge, Debus, Wolf and Strecker, and myself.

"*Third*—Pseudopurpurine } discovered by me in the commercial

"*Fourth*—Orange Matter, } purpurine of Kopp.

"*Fifth*—Purpuroxanthine or yellow matter, which I have also isolated from commercial purpurine. These pigments, perfectly definite and crystallizable, are distinguished by their physical properties, and especially by the absorption bands which they give with the spectroscope, by their solubility in various neutral or alkaline solvents, by their composition, and lastly, by their tinctorial properties."

On page 878 I find as follows:

Behavior in Dyeing.

"*Alizarine* gives fast colors resisting soap and nitro-muriate; of a violet red, of a violet very pure.

"*Purpurine* and orange matter yield fast colors and resist soap and nitro-muriate sufficiently well; red very brilliant and violet dull and gray.

"*Pseudopurpurine* gives shades passing away entirely with soap and nitro-muriate; red clear, but a little bricky; violet pale.

"*The yellow matter* yields colors moderately fast; orange yellow, with alumina; pale gray, with the iron mordants."

Again, in the "Moniteur Scientifique," 1875, page 562, I find an account by Alfred Naquet, of a research by A. Rosenstiehl, entitled "*Researches on the Relations which connect the different coloring matters of Madder, and the part which they play in Dyeing.*"

The author begins as follows:

"Since the remarkable work of Messrs. Schützenberger & Schiffert on the Alsace madder, it is admitted that this tinctorial root
85 contains four coloring matters—alizarine, pseudopurpurine, purpurine and purpurine hydrate; but the part of each of these substances in dyeing is ill-determined and it is not known which or how many constitute turkey-red, red, or the madder pink, which, by their brightness and their fastness, are considered the types of good colors. It is this gap which Mr. Rosenstiehl now fills. Mr. Schützenberger had asserted that these tints were exclusively due to alizarine, and that the purpurine was completely eliminated during the operations of cleaning and soaping. But in 1867, Mr. Camille Koechlin has combatted in this respect the ideas of Mr. Schützen-

berger. He has demonstrated in fact that the purest alizarine obtained so far, that is to say, sublimed alizarine or superheated with water and alcohol, and which are known to-day to contain some purpurine, yields with the iron mordants more beautiful violets than madder, but it is incapable of giving good reds with the alumina mordants."

Passing to the foot of page 563, we find as follows:

"*Concerning the Preparation of Pure Alizarine and its Tinctorial Properties.*

"Before the discovery of artificial alizarine, various madder extracts were used for the preparation of this body; among these, recently, the green and yellow alizarine, prepared from Alsace madder by the process of Mr. Kopp. Unfortunately, this alizarine—green or yellow—contains purpurine which the recommended methods of purification do not enable us to remove. Mr. Stenhouse first recognized this impurity, and Mr. Stockes has, a little later, estimated the proportion of purpurine at 30 per cent. of the entire mass. It is evident that with such a starting point all the analyses and all the descriptions must be erroneous, and we can see how, when the discovery of Messrs. Graebe and Liebermann was made, the identity of the red matter which they had obtained with alizarine was doubted, since the properties did not seem to coincide with those of the artificial product.

"This mistake is more natural since in the transformation of anthracene into alizarine there is always formed another coloring matter which changes to a certain degree the tinctorial properties of the first of these bodies.

"In fact, the tints obtained with the alizarine from madder and from the artificial alizarine differ; and if it is true that by purifying one and the other, partly by sublimation and partly by successive crystallizations, these differences are diminished, it is equally true that up to the present time no one has been able to make them disappear entirely. It is only recently that Mr. Rosenstiehl has been able to produce identical shades with the two alizarines by a method which he discovered by chance. This method consists in heating madder alizarine to 200°, in a closed vessel, with an aquious alkali solution. The duration of the contract should vary more or
86 less with the purity of the material which serves as the starting point; with commercial alizarine it should be seven hours. By this operation the purpurine is first destroyed. It forms, it is true, a brown substance and a solid body, which dye cotton a dull blue, but two or three crystallizations remove them.

"We can, however, much more easily and more rapidly arrive at a definite product by taking the artificial alizarine, which should be selected as pure as possible. It then contains as impurities only a little anthrachinone, oxanthrachinone, and isopurpurine, from which it is easily freed by two or three crystallizations from alcohol, especially if we take care to sublime it previously.

"Pure alizarine, crystallized from alcohol, presents itself in the form of fine yellow needles, or in the form of scales, of which the color is the more orange as they are thicker. At equal dimensions, these crystals are always less red than those of alizarine prepared according to the directions of the classical works, and which contain purpurine."

Passing to page 568 of the same article, we find as follows:

"To determine the relative quantities of alizarine and purpurine which are necessary for the production of madder red, Rosenstiehl took two titrated alcoholic solutions, one of alizarine and one of purpurine, and made numerous dyeing tests with mixtures in various proportions of these two solutions, securing the conditions for maximum; that is to say, by placing in the bath equivalent quantities of carbonate of lime and of the tinctorial matter. He was able to obtain a scale of tints very near together, in which he sought for the tones which came nearest to the beautiful reds and beautiful pinks of madder. He observed that the steps at the purpurine end of the scale (he added 5 per cent. at a time) resembled each other so much that 30 or 40 per cent. of alizarine modified but little the tint of the mixture, while the steps at the opposite extremity of the series differed much more among themselves. The beautiful madder red, which imitates the red of Adrianople and the beautiful red of the flowers of madder, are produced with the following mixture:

Purpurine.....	55 parts.
Alizarine.....	45 "

That is to say, almost a mixture of the two coloring substances in their molecular proportions. Rosenstiehl, in giving these figures, does not intend to say that the fixed quantity of each material corresponds to the above ratio. Such a conclusion would be hasty; but simply that he obtained beautiful reds in a bath containing alizarine, 45 per cent., purpurine, 55 per cent."

Again, if we examine the specimen of cloth dyed with sub-
87 limed natural alizarine, which is given with four other specimens on page 914 of the "Moniteur Scientifique" for 1869, in the article by Koechlin, which I have already quoted in my 29th answer, we will see that a comparison of the specimen dyed with the sublimed alizarine with the one dyed with the artificial alizarine of Meister, Lucius & Co. bears out the descriptions of the various authors above quoted, namely: the first yields a dull purplish red and a dead grayish pink, while at the same time its violet is peculiarly intense. I have also myself made a number of dyeing tests with chemically pure alizarine, a portion of which I have already introduced as an exhibit, Morton No. 8, and had in every case the same result, namely, dull blueish reds and pinks with alumina mordants, though a strong violet with iron mordants.

Q. 31. What can you say respecting the novelty of the alizarine described and claimed in complainant's patent Exhibit A?

A. I consider this to be an essentially new dyestuff, replacing

madder and its preparations to a great degree in the arts of dyeing and calico printing.

First. It is new as to its origin, being a purely artificial production, built up by a process of chemical synthesis from materials none of which contained it, or anything approaching it in character or properties.

Second. It is new in its composition, for it contains the substances isopurpurine and anthrapurpurine in large and effective proportions, these bodies being themselves effective dyeing principles, and unknown and not even existing before the discovery and preparation of artificial alizarine by Graebe and Liebermann.

Thirdly. It is new in its properties, being capable of producing tints in the processes of dyeing and calico printing, which cannot be obtained with the preparations of madder or other dyestuffs, previously known; and also showing a long series of new chemical properties by which these substances, anthrapurpurine, isopurpurine, as well as oxanthrachinone, anthraflavic acid, and several others are distinguished and recognized.

I will explain more fully the above enumerated points of novelty as follows:

First. As regards the artificial character of the substance:

When coal is subjected in close vessels to intense heat various reactions take place, causing the formation of an immense series of compounds, among which the chief consist of hydrogen and carbon combined in various proportions.

The coal tar, which contains a great number of these, being submitted to a second distillation, yields as one of its products, also at a very high temperature, the body named anthracene, which, when purified, is a white, waxy substance, much resembling in appearance stearic acid, as we find it in our common candles.

Now, it is this sort of colorless wax or grease which Graebe
88 and Liebermann have built up their artificial dye-stuff by a series of chemical treatments in which bichromate of potash, sulphuric acid, bromine, and caustic potash or soda, with the assistance of high temperatures, are the effective agents. In this manner they have, step by step, built up, by the addition of atoms and molecules to the anthracene which was their foundation, that beautiful and complex product, artificial alizarine.

It would be hard to imagine anything more completely unlike than is this to the process by which complex dye-stuffs, formed by the process of natural growth in plants, are extracted therefrom and more or less purified.

Second. As regards its newness of composition:

As I have already stated, the substances anthrapurpurine and isopurpurine exist in the artificial alizarine in effective quantities, which while they vary in different specimens with the variations in temperature and proportions of ingredients employed in their manufacture amount in many cases to more than 50 per cent. These substances are, moreover, as I have already shown, not only available but very

beautiful, and indeed, in the artificial alizarine, *essential* dyeing principles; they are essential to the production of these colors which are the characteristic and most valuable ones obtainable with this dye-stuff, artificial alizarine. They have been thoroughly studied by eminent chemists, as I have already shown, and proved to be entirely different from any substances previously known. I have also extracted them myself from the artificial alizarine, and have tested them as dyeing elements, and in reference to their various distinguishing characteristics or properties. Specimens of these substances and of cloth dyed with them I will introduce subsequently as exhibits.

Besides these substances, whose efficiency as dyeing elements has been fully recognized, there are several others present in artificial alizarine, whose properties have not yet received so much attention, but which we have strong reason to believe exert an important influence when the artificial alizarine is employed in the process of dyeing and calico printing.

Third. In reference to the newness of properties:

Numerous authorities, whom I have already quoted in my answer to question 29 of this record, assert most clearly that effects are obtained in dyeing and calico printing with the artificial alizarine which cannot be produced with madder or its extracts, and the researches of Perkin and Auerbach contain long lists of properties and tests by which anthrapurpurine and isopurpurine (essential constituents of artificial alizarine) may be distinguished from all other substances.

Q. 32. Following the directions given by Graebe and Liebermann in their patent, would it be possible to produce a product not containing in efficient quantities anthrapurpurine, isopurpurine,
89 and such other substances as you have stated to form essential constituents of the product, as a dye-stuff, substituting madder and its preparations?

A. It would not. As I have previously stated in an early answer, I have prepared this product a great number of times, with variations of temperature and proportions as authorized by the patent, and have never failed to obtain a product which, while varying in the proportion of its different constituents, in all cases contained them, as appeared among other things by its efficiency as a substitute for madder and its preparations. I did not, however, rely upon this test alone, but made separations into the elementary dyeing principles before mentioned in a number of instances.

Q. 33. What has been the result of the invention of Graebe and Liebermann in connection with the industries of dyeing and calico printing?

A. It has produced a practical revolution in these, inasmuch as the artificial alizarine has nearly superseded all the varieties of madder extracts, so that these have been withdrawn from the market, while even madder itself and its simple preparations, such as flowers of madder and garancine, are little used in comparison with their

consumption in former years, and the cultivation of this plant has been reduced to an insignificant percentage of what it was before, the ground formerly occupied for this purpose being now turned to other uses. It has immensely increased the range of application of topical printing and piece dyeing, so that numberless patterns and styles of goods which before could not have been produced at all, commercially, or only by much slower and much more expensive processes, are now readily manufactured by these means.

In 1871, when the manufacture had only recently commenced, the amount sent into the market was estimated at about 300,000 pounds; in 1872 it was about 1,000,000; in 1873 about 2,000,000, and at the present time the complainants are manufacturing about 3,000,000 pounds a year, or as a matter of fact, by the latest advices they are turning out 160 cwt. a day.

Q. 34. You state, in answer to Q. 22, "To test this idea they sought to reduce alizarine so as, if possible, to find out to what radical it was related. By heating it with zinc-dust they obtained a body possessing all the properties of anthracene, and were thus led to the conclusion that it was a chinone derivative belonging to this radical." Please state whether Graebe and Liebermann reduced any other substance besides alizarine into anthracene by the aid of zinc-dust.

A. They did. In a paper read before the Chemical Society at Berlin, on the 11th of May, 1868, published in the reports of this society for the same year, page 104, they say as follows:

"In the meeting of the 7th of March, we made the communication that we succeeded in obtaining anthracene from alizarine by the action of zinc-dust, and that we consequently gave to alizarine the formula

$$C_{14} H_6 \left\{ \begin{matrix} (H\ O)_2 \\ O''_2 \end{matrix} \right.$$

with the assistance of the same reagent we have also produced from purpurine, which stands near to alizarine, anthracene which is identical with the derivative derived from the first named dyestuff."

Q. 35. Please state what you find Graebe and Liebermann to have done in relation to the discovery of the dyestuff known as artificial alizarine?

A. Graebe and Libermann were, without question, the first to heat alizarine and also purpurine with zinc-dust, and so produced anthracene; they were the first to combine bromine with anthrachinone, derivative of anthracene, so as to form the new body, bibromanthrachinone; they were the first to combine chlorine with anthrachinone, so as to form the new body bichlor-anthrachinone; and they were the first to heat either of these new compounds with caustic alkalies, so as to produce the new substance, the compound dyestuff, which is the subject matter of their patent.

This new dyestuff is known in the arts of dyeing and printing by

the name "*artificial alizarine.*" All that has been manufactured up to the present day is made substantially by the process described by Graebe and Liebermann in their patent No. 95,465, reissue No. 4351; no modification having been introduced, except such as amount to the mere substitution of one equivalent material for another.

The process employed by Graebe and Liebermann is entirely original, and in the highest degree important and valuable; after they had made the important discovery that alizarine and purpurine bore a certain relation to anthracene, it by no means followed that any process would effect a conversion of anthracene into alizarene or purpurine. In fact, the latter is not produced in the process of manufacturing artificial alizarine, but, on the contrary, a number of other substances quite distinct from it in their properties are developed in this process, and some of them have proved to be dyeing elements very superior to purpurine and alizarine.

Q. 36. Can any preparation from madder root, such as the "flowers of madder," "garancine," "madder extracts," "green alizarine," "yellow alizarine," or the like be with any propriety called "artificial alizarne?"

A. They could not. The term "artificial" implies that the body so named has not been produced by processes of nature, but has been constructed by processes in which human art is the essential condition. All the preparations or extracts of madder above named are simply mixtures in which the available dyeing elements contained in the mature madder root are more or less freed from admixture or combination with other materials. If the extraction of these by
91 such treatment as is involved in the preparation of "flower of madder," etc., would entitle these extracts to be called artificial alizarine, white sugar could with equal propriety be called "artificial sugar," or absolute alcohol "artificial alcohol."

Q. 37. Do Graebe and Liebermann claim or describe in their patent that their dyestuff prepared from anthracene, called "artificial alizarine," is identical with the alizarine from madder root?

A. By no means. On the contrary, their statement is that their product "can be employed in the same manner as the different preparations of madder," which by no means either states or implies any identity between the substances, but on the contrary conveys the meaning that this is a new body which may be substituted successfully as a dyestuff for "madder extracts."

Q. 38. Having reference to the chemical literature of "madder," "madder alizarines" or "madder extracts," "artificial alizarine," and "chemically pure alizarine" extracted from the above dyestuffs, please state what you find to be in substance the opinion of the authors as to the similarity of these various materials?

A. The statements which have been made by various authors in reference to this subject may be divided into two classes. In the first case, purified alizarine supposed to be represented by the chemical formula $C_{14} H_8 O_4$ extracted from these sources, has been com-

pared in a number of instances and found to be essentially identical, and, in fact, this is generally admitted on all sides.

In the second place, comparisons have been made between this purified alizarine, commercial madder alizarines or madder extracts, and artificial alizarine. In this latter case, the results of such comparisons and investigations have in all cases shown essential theoretical and practical differences between these various materials, developing the fact that chemically pure alizarine existed as a dyeing element in madder, commercial madder alizarines, and in artificial alizarine, but that it was in neither case the only efficient dyeing element present, or capable by itself of taking the place of any of these complex bodies, but that on the contrary all these dyestuffs owe their efficiency to the co-existence of other dyeing elements besides chemically pure alizarine.

These essential co-existent elements are, in the case of madder and commercial madder alizarines, purpurine, pseudopurpurine, and purpuroxanthine; and in the case of artificial alizarine, they are the entirely different materials, anthrapurpurine and isopurpurine.

While such were the conclusions arrived at by those men who themselves investigated the subject, the attention of authors who were not themselves original investigators in this subject, but were engaged in the honorable and very useful labor of compiling books mainly from the published researches of others, was naturally
92 drawn, in the first instance and prominently, to the comparisons which had been made between pure alizarine extracted from madder and from the new product of Graebe and Liebermann, and the statements which they made upon the subject sometimes failed to express that the bodies compared were not the entire dyestuffs, but only this extracted element. As, however, the researches upon madder and artificial alizarine developed more fully their complex character and complex action as dyestuffs, and as these researches became generally known, these same authors, in subsequent publications, embodied these results and corrected their incomplete or erroneous statements as they had opportunity,

Q. 39. Please present such exhibits as you have referred to in previous portions of your testimony, or any others which you have prepared for this purpose, giving a full description of them, with such account of the methods of their preparation and character as may be necessary to fully explain them.

A. I present the accompanying specimens of anthrapurpurine in crystals by sublimation, marked Exhibit Morton No. 12, and of isopurpurine in like condition, marked Exhibit Morton No. 13, and would simply draw attention in this place to their entire difference in character from the sublimed purpurine or alizarine which I before presented, Exhibits Morton No. 7 and 8, although all were prepared under identical conditions. Their characteristics as practical dyeing elements will be illustrated in the swatches or specimens of dyed cloth which I will now present:

Swatches illustrating the effects of various materials when used in dyeing.

Exhibit Morton No. 9, showing comparative effects of *purpurine, chemically pure alizarine, madder extract,* and *artificial alizarine.*

This consists of four strips of cloth dyed in vertical stripes, with the materials named opposite to each strip on the card to which they are all attached, and shows the following characteristics:

The first strip, dyed with purpurine, shows the characteristic scarlet color of that substance with strong alumina mordant, and the yellowish pink which it gives with the lighter alumina mordant, also the inferior violet and black which it develops with the iron mordants. Its chocolate, also, with the mixed mordants, is peculiar and characteristic.

The second strip, dyed with chemically pure alizarine, shows the dull crimson and blueish or "dirty" pink which are the result of using this matter in a pure or unmixed state. The blueish purple and brownish black, with iron mordants, are also shown, and likewise the color which it imparts to the unmordanted parts of the cloth, and which is not removed by a thorough soaping.

93 *The third strip,* dyed with madder extract, shows the vivid red and the bright pink, which are the characteristic shades of madder and its commercial extracts, and which evidently result from the appropriate combination of the two characteristic colors shown in strips first and second or purpurine and chemically pure alizarine. The violet is here inferior to that of the chemically pure alizarine, but the superiority of the red and pink, which are the types of madder colors, is too manifest to need comment.

The fourth strip, dyed with artificial alizarine, shows the same peculiarities of fine and clear reds and pinks, while at the same time, on account the presence of anthrapurpurine, its violet and black are strong.

The method in which these specimens were made is as follows:

A large water-bath was prepared, capable of holding four beakers or cylindrical vessels of thin glass; into each of these was put 250 grammes of distilled water, .012 grammes of lime as acetate in solution.

The dyeing substances were then added to the several beakers in the following quantities:

Purpurine, .052 grammes; pure alizarine, .048 grammes; madder extract, .092 grammes; artificial alizarine, .048 grammes. The quantities of purpurine and pure alizarine represent the relation of their combining weights. Madder extract, containing a large amount of non-active material, a larger weight was found necessary to secure an equal amount of its effective ingredients. The artificial alizarine containing little beside effective matter, in the shape mainly of alizarine, anthrapurpurine, and isopurpurine, I used no more of it than of the pure alizarine.

This set of swatches seems to me to show conclusively that: 1st.

Artificial alizarine is an efficient substitute for madder extract. 2d. That chemically pure alizarine is not an efficient substitute for madder extract. 3d. That madder extract owes its superiority over chemically pure alizarine to the presence of purpurine.

To find if these characteristics would be greater or less with a less amount of dying material, I prepared the set of swatches marked Morton Exhibit No. 10, in which everything else remained the same, but the dyeing materials and lime were reduced to half. Exactly the same remarks which I have made about Exhibit No. 9 will, however, apply to this, so that it is evident these distinctions do not depend upon the quantities used, but are essential to the nature of the substances.

Swatches exhibiting the comparative tinctorial effects of purpurine, chemically pure alizarine, anthrapurpurine, and isopurpurine.

Exhibit Morton No. 11 consists of four strips of cloth from the same piece of cotton, prepared with mordants for the purpose of such dyeing tests, which I have used in the preparation of all the swatch exhibits which I introduce in this case. The quantities of
94 dyeing materials employed are the same in each case, except the chemically pure alizarine, which, having a lower chemical equivalent, calls for a corresponding reduction in the weight used to secure a strictly accurate comparison, although, as may be seen from my Exhibits 9 and 10, no change in any way effecting my conclusions is produced by a large variation in the amounts employed.

The *first two strips* showing purpurine and chemically pure alizarine need no mention here, as they correspond in all respects with the first two strips of Exhibit Morton No. 9, which contain the same substances in the same amounts.

The third strip is dyed with anthrapurpurine, whose red surpasses even that of purpurine in its scarlet character, while its pink is purer and its violet has become almost pure blue. Its color on the chocolate mordant is also easily distinguished from that of the purpurine, while in comparison with the pure alizarine there is not a single color at all alike between them. The strength of its violet is especially worthy of note, for this explains why, as we see in Exhibit Morton No. 9, the artificial alizarine, while giving a scarlet red like purpurine, also gives a rich violet like pure alizarine, and not a poor violet like madder extract. This is because the anthrapurpurine not only takes the part which purpurine plays in the madder for the red. but has also this capacity for producing a strong, bluish violet which purpurine lacks; anthrapurpurine also differs from purpurine in being a much faster color.

The fourth strip is dyed with isopurpurine, and the difference between its colors and those produced by purpurine, though less marked, is very manifest. The red and pink are more crimson and bluish respectively, the violet is also bluer, and the black stronger. It differs, moreover, from the chemically pure alizarine in every color, and in the most marked degree.

It is worthy of note that of these four different dyeing elements, whose practical effect on mordanted cloth are here exhibited, the one whose effects are least brilliant is the chemically pure alizarine, which is the only common dyeing element in the commercial dye-stuffs, "madder alizarines" or "madder extracts," and "artificial alizarine." We therefore see how little weight there is in the argument that the dye-stuffs are identical because they contain this element in common, while at the same time they contain in common none of the other materials by which colors so much more brilliant are produced. To a chemist desiring to experiment with pure alizarine, these other bodies might be well regarded as impurities; but to the practical dyer and printer desiring to manufacture goods with the best colors, brilliant and permanent, such as turkey-red, madder reds and pinks, they would be the most valuable constituents of any dye-stuff which contained them.

(Counsel for complainant offers in evidence the swatches,
95 and the specimens of anthrapurpurine and isopurpurine, produced by the witness and referred to in his last answer, and the same are marked respectively Exhibits Morton Nos. 9, 10, 11, 12, and 13.)

HENRY MORTON.

Subscribed and sworn to before me this 9th day of October, 1876.

R. E. STILWELL,
U. S. Com'r.

96 NEW YORK, *Nov. 16th*, 1876, 2 o'clock p. m.

Present: Counsel for the respective parties.

Cross-examination of Prof. Henry Morton by Mr. Dickerson:

x-q. 4. In your 33d answer, you say that "the complainants are manufacturing about 3,000,000 of pounds a year, or, as a mater of fact, by the latest advices they are turning out 160 cwt. a day." Have you any knowledge of the fact there stated, or is that hearsay?

A. It is, in the technical sense, hearsay; that is to say, I derived my information from a confidential letter from one of the firm in Germany to Mr. Pickhardt, and which he (Mr. Pickhardt) showed to me.

x-q. 41. Did that confidential letter inform you that the complainants were manufacturing alizarine by the process described in Graebe and Liebermann's patent No. 95,465, reissue 4321, in this case?

A. It did not.

x-q. 42. Did you suppose, when you made that statement, that the complainants were manufacturing that alizarine by the process described in that patent?

A. I knew that they were manufacturing it by a process which

differed from that described in the complainants' patent to the extent of substituting one chemical equivalent for another.

x-q. 43. Question repeated.

A. I had no means of forming any judgment as to the precise character of the process practiced by complainants; but having a number of times analyzed their products, and having found them to contain anthrachinone, monoxanthrachinone, anthrapurpurine, isopurpurine, and alizarine, the first of which represents the first principal step in the process of complainants' patent, that is, the conversion of anthracene into anthrachinone, and the rest of which represent the second principal step of the process, that is, the conversion of anthrachinone into the various dyeing elements which together constitute the product of complainants' patent, known as artificial alizarine, I feel myself justified in saying that I know that complainants manufacture either by the exact process of the patent or by one which in its essential steps and their result is equivalent thereto.

x-q. 44. Will you not do me the favor, without argument or circumlocution, to answer the very simple question whether you believe that the complainants were manufacturing that alizarine by the process described in the patent? I have not asked whether you thought they used an equivalent or not, and I don't want that in the answer.

97 A. I believe that the complainants use sulphuric acid in the place of bromine or chlorine in their manufacture.

x-q. 45. Then you do not believe that they manufacture their alizarine according to the process described in that patent. Is not that so?

A. My answer to that question depends upon the definition of the word process.

x-q. 46. By process I intend both the manipulation and the means, elements, and reagents described in that patent, and with that definition I ask an answer.

A. If by a process I understand strictly the use of specified means, elements, and reagents named, excluding the substitution of one equivalent for another, then the complainants used a different process. If, however, by a process I understand in the wider sense the employment of certain means, elements, and reagents, or their respective known equivalents, then the complainants use the same process as that disclosed in the patent.

x-q. 47. Do you not also believe that the complainants manufacture their alizarine by a process or processes that have been invented and patented since the date of Graebe and Liebermann's patent?

A. I do not.

x-q. 48. Have you never heard, from your employers or otherwise, that the processes used by them are the subject of patents both in Germany and in England?

A. I have heard something to that effect, but I have also seen cer-

tified statements by Graebe and by Caro, carrying back the invention of this modification of their process to a date which I believe anticipates the date of this patent.

x-q. 49. I have not asked you whether in a lawsuit the patents in accordance with which the complainants are manufacturing alizarine could be upheld or not, nor whether Graebe and Caro are the real inventors of the process patented by others, and I don't want that opinion. My question is whether you do not believe that there are patents in existence subsequent to Graebe's original patent in issue in this case, in accordance with which the complainants are manufacturing alizarine?

A. I have every desire possible to meet your wishes on this subject. In question 47 you asked me, "Do you not also believe that the complainants manufacture their alizarine by a process or processes that had been invented and patented since the date of Graebe and Liebermann's patent?" and in question 48 you ask, "Have you never heard from your employers or otherwise that the processes used by them are the subjects of patents both in Germany and England?" Considering these questions in their natural connection, I stated to the best of my ability what I knew about the invention or development of the process, and now add what I omitted by
98 an oversight in my last answer, that I believe Graebe and Liebermann or their representatives did take out a patent in England for this form of their process, but were refused one in Germany, on the ground that it did not differ from that of their original patent.

x-q. 50. Do you not believe, then, that the complainants are manufacturing their alizarine by a process which has been patented since the date of Graebe and Liebermann's original patent, either by Graebe and Liebermann, or by others?

A. I do not think that that is a correct statement of the facts. I do not think, as I have already stated, that the processes are different, in the sense in which I understand the wood, and therefore do not consider that the fact that when Graebe and Liebermann, or their representatives, took out their patent in England, they so far modified it as to substitute the use of sulphuric acid for bromine, is correctly expressed by the language you have used.

x-q. 51. Won't you answer the question, without arguing what you think Graebe's rights were, or what the effect of his patent was, or whether you know more than he did when he applied for that second patent? The question simply is whether the complainants' manufacture is not in accordance with patents taken since the date of Graebe and Liebermann's original patent, by somebody?

A. I am not aware that my previous answers contained any of the statements which you suggest, but believe that they simply contain what is necessary to make clear what are the actual facts, as I believe them to exist, in this connection. Having made these explanations, I think I shall not be misunderstood in saying that the com-

plainants manufacture artificial alizarine in accordance with the methods described in a patent granted since their first.

x-q. 52. Is it not also true that their original patent, similar to the one in issue in this case, was cancelled in Germany, because a successful manufacture according to it was not established?

(Counsel for complainants objects to the question as incompetent and not matter of cross-examination, and irrelevant and immaterial.)

A. It is not true. The facts, as I believe them to be, are as follows:

An application was made for a patent in Prussia. While this was pending the inventors applied to modify their patent in this very respect of substituting sulphuric acid for bromine. They were told that this modification was simply an equivalent, and therefore not allowable as a basis for fresh action. At the same time, seemingly vexatious delays and self-contradictory objections were thrown in their way by officials connected with the patent office, and though the manufacture had already reached large proportion in their hands at their present works, they finally abandoned in disgust their
99 attempts to obtain a Prussian patent, which would only have run for five years at best. No patent of theirs was cancelled, as you suggest, for the best possible of reasons, viz: that no such patent was ever taken out, the matter having gone no further than an application.

Q. 53. Do you believe it to be true that there is or ever has been carried on a manufacture of alizarine on a commercial scale, in the manner described in Graebe and Liebermann's patent; if so, where do you believe such manufacture to have been carried on?

A. I believe that it was so carried on for a short time by Graebe, Liebermann & Caro, at the works of complainants.

x-q. 54. How many years ago, how short a time, and to what extent?

A. This was, as I believe, in 1869, and my impression is that the quantities amounted to some hundreds of pounds.

x-q. 55. Do you believe it to be true that the alizarine sold by A. Cochrane & Co., and examined by you, was manufactured by the process described in reissue No. 4321?

A. Not having witnessed the manufacture, I cannot say positively as to this, but I do not know that if the process of Graebe and Liebermann's patent had been followed it would have produced just such a product as that which I have examined in the present case.

x-q. 56. I have not asked for your knowledge, but for your belief or opinion. Do you think or believe that it was manufactured by that process?

(Counsel for complainants objects to the question as incompetent and immaterial.)

A. The sulphuric acid being much cheaper than bromine or chlorine, I have no doubt that any manufacturer of artificial alizarine would employ it in preference to the others, but no process hav-

ing been yet discovered by which artificial alizarine can be commercially produced except that involving the series of transformations which constitute the main features of Graebe and Liebermann's process, I believe that this material was made by following the Graebe and Liebermann process, with the substitution of sulphuric acid for bromine or chlorine.

x-q. 57. Don't you believe it was made by a process patented since the original patent of Graebe and Liebermann?

A. Bearing in mind my previous explanations on this subject, I do.

x-q. 58. Was not the similarity between alizarine and the products of coal tar pointed out as much as ten years before Graebe and Liebermann's process was invented, with a prophecy that alizarine would be produced out of those products?

A. There is not the slightest similarity between alizarine and anything which is properly understood as a product of coar tar.

100 By products of coal tar, chemists understand such bodies as benzole, napthaline, anthracene, chrysene, pyrene, and a host of other materials which are produced from coal tar by fractional or destructive distillations, or the like. By combining some of these products with other elements, countless new substances have been produced which are known as derivatives of such products. The relations of composition between alizarine and some coal tar products had long ago suggested to chemists the hope of synthesis or building up of alizarine from certain of these; but those that were so regarded had no sort of similarity to alizarine. For example—naphthaline, which is a white, crystalline, waxy substance, was generally regarded as the most likely to prove the parent of an artificial alizarine, and indeed Roussin went so far as to announce the production of artificial alizarine from naphthaline, having in fact obtained a body having tinctorial properties of some sort, resembling those of alizarine.

x-q. 59. Was not the resemblance between the molecular arrangements of certain products of coal tar and the supposed molecular arrangement of alizarine pointed out ten years before Graebe's process was invented, and a prophesy made that alizarine would be derived from those products by making some small change in their molecular arrangement?

A. I know of no *such* prophesy or statement of relations.

Adjourned to Wednesday, Nov. 22d, at 10:30 a. m.

NEW YORK, *Dec.* 22, 1876.

Cross-examination of Prof. MORTON continued.

Present—counsel as before.

Further cross-examination waived.

Cross-examination closed.

HENRY MORTON.

Subscribed and sworn to before me this 22d day of December, A. D. 1876.

R. E. STILWELL, *Examiner.*

101 Circuit Court of the United States for the southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et al.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
HAMILTON MANUFACTUBING COMP'Y.

EVIDENCE FOR COMPLAINANTS.

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States, in equity, as amended, before me.

JOHN G. STETSON, *Examiner.*

BOSTON, *Dec.* 4, 1876.

Present—J. Van Santvoord, esq., of counsel for complainants; E. N. Dickerson, esq., of counsel for defendants.

Deposition of John M. Ordway.

Direct examination by J. Van Santvoord, esq., of counsel for complainants:

Q. 1. Please state your name, age, residence and occupation.

A. John M. Ordway; 53; Boston, Mass.; Professor of Industrial Chemistry and Metallurgy in the Massachusetts Institute of Technology.

Q. 2. What opportunities have you had of becoming practically acquainted with the processes used in the arts of dyeing and calico printing?

A. From boyhood I have associated with those who were engaged directly in the various processes of calico printing. As a manufacturing chemist, I have been brought into relations with the printers. For six years I was connected with the Manchester Print
102 Works, in Manchester, N. H.; first as chemist, next as manager, and finally as superintendent.

Q. 3. What experience have you had in giving testimony as an expert in patent suits?

A. I have several times been employed as an expert in cases relating to chemical patents, and have often been consulted as to the specifications of chemical patents.

Q. 4. Have you read, and do you understand, the patent of complainants marked Exhibit A, being reissue No. 4321?

A. I have read the specification of that patent, and believe I understand the purport thereof.

Q. 5. What do you understand to be indicated by the word "alizarine" as therein used?

A. I understand a substance which can be employed in the same manner and for the same purposes as madder, or the different preparations of madder, the word alizarine being sometimes used as a generic term to designate the coloring matter of madder.

Q. 6. Do you understand that this word as used in said patent necessarily implies that the product therein described contains anything found in madder root or its preparations?

A. There is nothing in this specification which intimates that the artificial alizarine therein described is the same alizarine which is contained in madder, or that it bears any other relation to madder than being capable of taking its place as a dyestuff.

Q. 7. What was the signification of the word alizarine as used by those skilled in the art of dyeing and calico printing, prior to the date of the patent above referred to?

A. For a long time the word alizarine was used among printers and dealers in dyestuffs to indicate that preparation which was made by Messrs. Pinkoff and Schunck, which is sometimes called "Pinkoffin." It was afterwards used with the prefix "green" to designate a preparation of madder made according to a process devised by Amile Kopp. In confirmation of the former statement, I will refer to a lecture on "Coal Tar Colors and on Recent Improvements and Progress in Dyeing and Calico Printing," by Dr. F. C. Calvert, which was published over ten years ago. In this publication specimens dyed with Pinkoffin are to be found on page 5, and marked "Specimens of Alizarine Styles."

Q. 8. Have you examined any of the contents of the bottle marked "Artificial Alizarine, Exhibit Browne No. 1, J. G. S., examiner," for the purpose of ascertaining what those contents are, and, if yea, what do you find the same to be?

A. I have examined the contents of that bottle, and find
103 it to correspond in appearance and character with other specimens of artificial alizarine found in commerce.

Q. 9. Have you examined the artificial alizarine prepared in accordance with complainant's patent, and also the various commercial preparations of madder with a view of determining their relative efficiency as dye-stuffs? and, if so, please state the results of your examination.

A. I have examined a specimen of crude artificial alizarine sent me by Mr. Carl Pickhardt, and said to be made exactly according to the original specification of Graebe and Liebermann, and according to the reissue No. 4321, dated April 4, 1871, Exhibit A, in this case; also the artificial alizarine V D; also the artificial alizarine D, and the artificial alizarine of Exhibit Browne No. 1, all of which

were sent me by Mr. Carl Pickhardt. I have examined also the flowers of madder, the commercial alizarine, the garancine of commerce marked V C, as well as Meissonier's extract of madder, all of which were sent me by Mr. Carl Pickhardt. I have made comparative dyeing tests with all these articles and with other artificial alizarine found in commerce, and with garancine made at Tiel, in Holland, and with Hunter's extract of madder, and with Kopp's green alizarine. I find that in respect to fastness the colors produced by the artificial alizarines are superior to those produced with the preparations of madder, and in respect to brilliancy they are by no means inferior.

Q. 10. Did you find any difference between the various specimens of artificial alizarine, which you have named in the previous answer, as regards their effects in dyeing?

A. I find some difference in respect to the tints produced with the different mordants, and but little difference with respect to fastness.

Q. 11. Did you find any difference in reference to the tints produced by the various madder preparations named by you in answer to interrogatory 9?

A. I found considerable difference in the tints produced and in the fastness of the colors.

Q. 12. Do you consider all the artificial alizarines, named by you in answer to interrogatory 9, equally good, or in other words equal in quality or efficiency as dyestuffs?

A. Not precisely equal but nearly so, as some are a little thicker than others, and probably contain a little more of the coloring matter.

Q. 13. What can you say respecting the novelty of the artificial alizarine described and claimed in complainant's patent, Exhibit A?

A. I consider this to be an entirely new product, and according to my reading it has been universally admitted by chemists to be a new and very valuable discovery, and that the credit of this discovery is due solely to Graebe and Liebermann.

104 Q. 14. What has been the result of this invention of Graebe and Liebermann in connection with the industries of dyeing and calico printing?

A. It bids fair to revolutionize the whole business of calico printing so far as the so-called madder styles are concerned. It enables us to obtain purer colors with much greater ease in the manipulation, and consequently, so far as the work is concerned, at a lower cost.

Q. 15. Do what you have described as madder styles constitute an important item in the product of print works?

A. By far the largest part of all the calicos sent into market have been produced by the madder style, and the only prints which have remained prominently in demand are generally known as madder prints.

Q. 16. Will you please describe briefly the main features of the method by which these madder styles were produced prior to the in-

troduction of artificial alizarine, and then the method by which they are produced with the aid of this dyestuff?

A. In the madder style the mordants are first thickened with starch or gum, and printed on the cloth. The cloth is then dried at a high temperature. It is then exposed for a short time to a warm, damp atmosphere in the so-called aging box. It is then exposed to the air in an aging room for several days, in order to allow the mordant to combine more intimately with the fibre. The cloth is then passed through a solution of cow dung, or of arseniate of soda, or of silicate of soda, to remove the gum and leave the mordant in combination with the fibre. It is then dyed with madder or garancine, or commercial alizarine, mixed with more or less quercitron bark, sumac, and hypernic wood, together with a small quantity of chalk. This dyeing operation is carried on in a large vat filled with water, which is gradually heated nearly or quite to the boiling point, the cloth being kept constantly moved in the dyeing liquid. The dyeing with madder and the preparations of madder requires more care than the dyeing with most other stuffs on account of the peculiar nature of the coloring principles contained in madder and its preparations. After dyeing, the cloth is washed, and then it is very commonly passed for some time through a hot mixture of bran and water. It is then washed, and it is passed first through hot water, then through a weak solution of chloride of lime, then through water again, then it is passed through starch paste, to which a little ultramarine, or extract of indigo, has been added. It is then dried, sprinkled, calendered, and folded. In the case of madder pinks, the dyeing is effected with a large quantity of madder, and the cloth is subsequently boiled for some hours in a strong solution of soap. It is then washed, passed through a solution of perchloride of tin, washed, and again boiled with soap. In this way a great excess of color is first imparted to the cloth, and the dull part of that color is removed by the soaping.

The artificial alizarine may be, and sometimes is, used for dyeing in the same way as the preparations of madder, but it is more commonly used for steam colors, the steam colors being more easily produced, and requiring less time for the production of the finished prints. In the steam style the color and mordant are mixed with a suitable quantity of water. The mixture is thickened with starch or gum. It is then printed on cloth. The cloth is then dried, and without waiting for aging, it is hung for thirty minutes or more in a tight chest, to which dry steam, at a temperature of about 216° Fahrenheit, is admitted. In order to produce an evenness in the colors from end to end of the pieces the cloth is then folded over end for end, and hung again in the steaming box for thirty minutes or more. It is then washed, starched, calendered and folded. The whole of these operations may be carried out in a single day, and the colors produced by artificial alizarine in this steam style are about as fast as the colors produced in the old

madder style, which required a week or more and a great deal of space.

Q. 17. Could madder, garancine, commercial alizarine, and the like, be used in place of artificial alizarine in the steam style or rapid method which you have just described?

A. Madder contains but about one and a half per cent. of useful coloring matter; garancine and commercial alizarine not more than five per cent. of coloring matter; so that it is unpractical to use these materials as such, and the coloring matter is so very slightly soluble in water that we cannot in the case of madder, as in the case of quercitron bark, log wood, hypernic wood, yellow berries, cochineal, etc., make an aqueous decoction and boil it down to a suitable strength for producing the colors on the cloth. Extracts of madder have, however, been made by resorting to various other solvents, such as an alkaline liquid or alcohol; but these madder extracts contain various impurities which interfere more or less with the successful production of the color, and their cost has been such as to preclude any more than a sparing use of them, and there are some practical difficulties in the way of printing with color made with madder extract, which difficulties are not experienced with the artificial alizarines. Moreover, the cost of artificial alizarine is now such that we can afford to use it for the steam style just as well as garancine for the madder style.

Q. 18. As a practical matter, then, you consider that the general employment of the steam style, or rapid method of printing, depends upon the existence and supply of artificial alizarine. Am I right?

A. You are.

Q. 19. Has the introduction of artificial alizarine effected any economy or improvement in what is known as "piece dyeing" for turkey red?

A. The proper dyeing of turkey red with madder and a mordant of fatty matter, was a very long and troublesome operation; but now, by the help of artificial alizarine, it is possible to produce by padding and steaming a very good substitute for the old turkey red, and I know of no
106 way in which so good a substitute for turkey dyed red cloth could be produced before the introduction of artificial alizarine. By padding I mean impregnating the cloth throughout with the color mixture which is ordinarily used for topical printing, a plain roller being substituted for a roller on which figures have been engraved.

Q. 20. Can any preparation from madder root, such as the "flowers of madder," "garancine," "madder extracts," "green alizarine," "commercial alizarine," or the like, be with any propriety called "artificial alizarine?"

A. I do not consider that they can. Chemists usually understand by the term artificial dye-stuffs those which are produced from none

of the dyes contained in plants or animals, nor from the glucosides of those principles.

Q. 21. Do Graebe and Liebermann claim or describe in their patent that their dye-stuff prepared from anthracine, called artificial alizarine, is identical with the alizarine from madder root?

A. They do not. They simply say that it may be used in the same manner as the different preparations from madder.

Q. 22. Was chemically pure alizarine ever used as a dye-stuff?

A. I have never known it to be so used, nor have I ever read or heard of its being so used.

Q. 23. What do you understand by the statement you have just quoted from the patent, Exhibit A, to the effect that the alizarine there described "can be employed in the same manner as the different preparations from madder?"

A. I understand that the artificial alizarine may be used for dyeing and for steam work, and as an efficient substitute for madder or the preparations of madder.

Q. 24. How are the various madder preparations known prior to the patent Exhibit A, described among those using them and dealing in them?

A. They were generally spoken of in reference to their method of preparations and the uses to which they may be put, and sometimes are spoken of as being so much stronger and so much weaker than madder; thus garancine was spoken of as being about three times as strong as madder and not injuring the whites in dyeing, and alizarine—that is, commercial alizarine, or pinkoffin—was spoken of as being particularly adapted to dyeing bright purples.

Q. 25. Having in view the state of the art at the time of the grant to Graebe and Liebermann of their patent, Exhibit A, and of their original patent, do you regard their description therein of their product as correct?

A. I do. They simply describe their product as consisting of yellow flocks without stating what particular principles or ingredients those flocks contained. In fact, the state of science was such
107 at that time that it was impossible to state precisely what the product was in a chemical point of view, nor can it be said that the state of chemical science is such at the present moment that we know precisely what artificial alizarine is. All we can be justified in saying at present is that it is a mixture of substances capable of replacing madder as a dye-stuff, but that it contains some substances which are not found in madder and which yet contribute in a great degree to the production of fast colors.

Q. 26. When the term "pure" is used in the arts as in the statement that a substance is so pure that it can be used for a certain purpose, is this understood to mean chemically pure, or in what sense is the word employed?

A. It seldom means absolutely pure, but is usually understood to imply that the substance is free from foreign matters which might in some cases prove injurious for the uses to which it is to be applied;

thus I have made and sold a great many carboys of pure nitric acid, which was marked and sold as pure nitric acid. By this was meant not that the nitric acid was absolutely free from iron, or alumina, or nitrous acid, or ammonia, or potash, or soda, or lead, but that it was so far pure from chlorine that it was suitable for dissolving silver, one of the chief uses to which nitric acid is put. We distinguish in commerce and the arts substances as being crude, as being adulterated, as being pure, and as being absolutely or chemically pure. A dye-stuff may be said to be pure when it contains nothing which is liable to injure the tint which the dyer desires to produce, and yet the coloring matter itself may be made up of several distinct chemical substances, each of which contributes to produce the desired effect.

Q. 27. Have you read the various descriptions of processes for the manufacture of artificial alizarine which have been published subsequently to Graebe & Liebermann's original patent; and if so, what do you understand to be their resemblance to or difference from the process described in said patent of Graebe and Liebermann?

A. I have examined these different processes, and I consider them to be essentially the same. The process described by Graebe and Liebermann depends, in the first place, upon the conversion of anthracene into anthrachinone, which is simply a process of oxidation, and it is immaterial whether this oxidation is performed by means of chromic acid, or peroxide of manganese, or nitric acid, or bromine, or chlorine, chlorate of potash, or nitrate of potash. The anthrachinone is then combined with what is denominated in chemistry a radical, and it is immaterial whether this is chlorine, or bromine, or nitryl, or sulphuryl. It simply requires that there should be something in chemical combination with the anthrachinone which may afterwards be replaced by hydroxyl, and which may be withdrawn from the combination by itself combining with the hydrogen of the hydrate of potassium or of sodium. In the original specification this radical is bromine or chlorine. In the subsequent so called improvements the radical to be replaced is sulphuryl or nitryl. The principle involved is the same in all cases, and any chemist who had found that bromine would answer the purpose would naturally be led to suppose that chlorine, or iodine, or NO_2 or SO_2 might be made to replace the bromine in bibromanthrachinone. It matters little whether the first two steps succeed each other in the order which I have named, or in any other order. The formation of anthrachinone, or any equivalent, and the formation of bibromanthrachinone, or any equivalent, and the subsequent decomposition of bibromanthrachinone, or its equivalent, by hydrate of potassium, or of sodium, are the essential steps of the process.

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The starting point in all cases is the same, namely, anthracene; the intermediate products are to all intents and purposes the same; the final operation is the same; and the final product, artificial alizarine, is the same.

Q. 28. What, if any, analogy do you find between the process by

which artificial alizarine was produced by Graebe and Liebermann, and that by which madder alizarine is formed in the root of the madder plant?

A. I see no analogy, whatever. In the first place the madder alizarine, like all other vegetable substances, is produced from the carbonic acid of the air and from water by a process involving the action of life, directing the chemical agency of sunlight, and this process is mainly one of deoxidation, for vegetable substances all contain a less relative amount of oxygen than the carbonic acid from which they are formed. This action goes on at the ordinary temperature of the air, and without the assistance of any of the powerful chemicals which we use in the laboratory. On the other hand, artificial alizarine is produced from anthracine, which is itself a product of the decomposition of coal at a bright red heat, and anthracene is not known to occur at all in the vegetable kingdom. This anthracene which contains no oxygen at all requires for its change into anthrachinone the most powerful oxidizing agents which are at the command of the chemist, and the chemical agents which are used would disintegrate and destroy any ordinary vegetable matter. The chemical agents which are combined with the anthrachinone in one of the steps of the manufacture of artificial alizarine are of a powerfully corrosive nature, and the heat which is used in all these steps is far above the boiling point of water, and the heat so used is of such long continuance that any but the most stable bodies would be destroyed by it.

Adjourned.

DEC. 5th, 1876.

109 Q. 29. You say in answer to int. 12, speaking of the specimens of artificial alazarine, named in your answer to int. 9, that some are a little thicker than others. Which specimens are thicker than others?

A. The specimen "Artificial Alizarine Exhibit Browne 1," was thicker than any of the others, as it had evidently lost some of its original water by evaporation. The specimen marked "Artificial Alizarine V D" was next in point of thickness. The specimen marked "Artificial Alizarine D" was somewhat thinner than either of those just mentioned; and the specimen of commercial artificial alizarine which I had on hand was still thinner. The specimen made by Carl Pickhardt himself had not been refined and brought to the state of paste, but was still in the form of a very thin liquid.

Q. 30. Was you able to discover any other difference in quality between those several specimens of artificial alizarine besides what you have mentioned in your last answer?

A. There was a very slight difference in respect to the goodness of the tints produced. That which was made by Carl Pickhardt appeared on a second test the best of all. Between the specimens marked "Exhibit Browne 1" and "Artificial Alizarine V D" it was difficult to choose. The specimen marked "Artificial Alizarine

D" was not fully equal to that marked V D, and the specimen which I had on hand was not quite equal to the others in the goodness of the tints produced. It would be fair to say that the first three named were to all intents and purposes the same.

Q. 31. If you have made any swatches or dyeing tests with artificial alizarine and with preparations of madder for the purpose of ascertaining the merits of these articles as dye-stuffs, please produce them, to be used as exhibits in this case, and describe what they are.

A. I have here swatches which I have dyed with the artificial alizarine marked "V D," the artificial alizarine marked "Exhibit Browne 1," the artificial alizarine made by Mr. Carl Pickhardt according to the original bromine process, and an artificial alizarine which I had on hand before receiving those specimens from Mr. Carl Pickhardt. I have also here swatches which I have dyed with garancine V C, with flowers of madder, with Meissonier's extract of madder, and with Hunter's extract of madder. One set of these swatches has been simply washed with water; one set has been boiled for some time with soap; and a third set, after being boiled with soap and dried, has been padded with a thickened solution of red prussiate of potash, dried, heated with a solution of caustic soda, then with boiling water, and then boiled with soap. The effect of this latter treament is such as to show a very marked difference in the fastness of the colors produced by artificial alizarine and those produced by the preparations of madder.

The specimens marked "pb," "pb^{I}," and "pb^{II}" have been produced with Mr. Carl Pickhardt's artificial alizarine.

The specimens marked "g," "g^{I}," and "g^{II}" have been dyed with the artificial alizarine V D.

The specimens marked "d," "d^{I}," and "d^{II}" were dyed with some of the artificial alizarine marked "Exhibit Browne 1."

The specimens marked "10," "10^{I}," and "10^{II}" were dyed with the artificial alizarine which I had on hand.

The specimens marked "m," "m^{I}," and "m^{II}" were dyed with the garancine V C.

The specimens marked "7," "7^{I}," and "7^{II}" were dyed with the flowers of madder.

The specimens marked "6," "6^{I}," and "6^{II}" were dyed with Hunter's extract of madder.

The specimens marked "f," "f^{I}," and "f^{II}" were dyed with Meissonier's extract of madder.

The exhibits I will mount on cards for convenience of reference, and I will give on the margin of the cards such a designation as will identify the several exhibits.

(Counsel for complainants offers in evidence the several exhibits produced and referred to in the last answer, and they are marked respectively: Complainants' Exhibit Ordway No. 5, 6, 7, 8.—J. G. S., exam'r, Jan. 24, 1877.)

Q. 32. Was you present and did you hear the witness, James Har-

ley, give his testimony in this case in answer to int. 35, and do you know the exhibits he referred to?

A. I was here and arranged the exhibits for his inspection to which he referred in that answer without giving him any intimation as to the specific dyestuffs which were used in making them, and these exhibits are the same as those marked by the same letters among the exhibits which I have just produced.

Q. 33. Did you yourself dye the eight swatches which are referred to in int. 35 and the answer thereto in said Harley's testimony?

A. I did dye these swatches, and prepared them with the materials and by the methods which I have described in answer to int. 31, where I referred to them. I dyed all the swatches named in my answer to int. 31.

Q. 34. In a previous answer you have stated that the cloth dyed with madder and with commercial preparations of madder did not show as fast colors as that dyed with artificial alizarine; are you able to assign any reason for this difference, or to what do you attribute it?

111 A. I should consider this difference as indicating that the mixture of coloring matters contained in artificial alizarine is different in its character from the mixture of coloring matters contained in madder and the preparations of madder.

Q. 35. Is there anything among the exhibits which you have produced which illustrates this difference in character?

A. One out of each series of those exhibits has been treated with ferricyanide of potassium, which is a powerful oxidizing agent, and is calculated to destroy all such colors as are not very fast; and the effect of this oxidizing or bleaching treatment on the colors dyed with the preparations of madder is very decided, while the effect on the colors produced by the artificial alizarines is very slight and but little detrimental.

Q. 36. Have you read the testimony thus far given in this suit by Prof. Henry Morton, and if you have, please state whether or not you agree with what he has stated in his testimony on the questions of the novelty and usefulness of the product "artificial alizarine," described and claimed in complainants' patent No. 4321, Exhibit A, in this case?

A. I have examined the testimony thus far given by Prof. Morton, and consider the replies given by him respecting the novelty and usefulness of Graebe and Liebermann's invention to be perfectly correct.

Q. 37. Please state also whether or not you agree with Prof. Morton in what he has stated in his said testimony as to the non-identity of artificial alizarine with madder or any of the preparations of madder?

A. I do agree fully with him, and I believe the testimony which he has given is fully borne out by the literature of the subject. As far as I can learn, it is the universal belief of scientific men that the discovery of artificial alizarine is due solely to Messrs. Graebe and

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Q. 37. Please state also whether or not you agree with Prof. Morton in what he has stated in his said testimony as to the non-identity of artificial alizarine with madder or any of the preparations of madder?

A. I do agree fully with him, and I believe the testimony which he has given is fully borne out by the literature of the subject. As far as I can learn, it is the universal belief of scientific men that the discovery of artificial alizarine is due solely to Messrs. Graebe and

Liebermann, and it seems to be still a matter of doubt among scientific men as to whether any of the substances contained in artificial alizarine are fully identical with any of the substances contained in madder; and I believe it to be well established that there are several important substances contained in artificial alizarine which have never been found in madder or its preparations, and are never likely to be found in them.

(Cross-examination of this witness is reserved.)

JOHN M. ORDWAY.

Attest: JOHN G. STETSON,
Examiner.

112 BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et al.

NEW YORK, *Jan.* 3*d*, 1877.

Present: J. Van Santvoord, esq., for compl'ts; E. N. Dickerson, esq., for def'ts.

Continuation of the examination of Prof. ORDWAY.

Q. 38. On what day did you receive the package from Mr. Carl Pickhardt, to which you refer in your answer?

A. I received the package by express from Carl Pickhardt November 21st, 1876; the articles were contained in a box, which was tied up, and the string was sealed with a seal which proved to be identical with one sent on by mail by Carl Pickhardt.

Cross-examined by Mr. Dickerson:

x-q. 39. If I understand your testimony, you are of opinion that Graebe and Liebermann invented not only the method described by them, but also, in the words of the patent, "any other method which will produce a like result." Am I right?

A. It is my opinion that Graebe and Liebermann invented the precise method which is described in their specification, and some other methods which are not therein literally described.

x-q. 40. Is it your opinion that they invented every "other method which would produce a like result?"

(Objected to by counsel for complainants, because it calls for an opinion and not for the witness's knowledge, and as irrelevant.)

A. It is not my opinion that they have invented every method which may hereafter, in the progress of science, be found to produce a like result, but they invented the only method which has heretofore been used to produce this result.

x-q. 41. Have you any personal knowledge of the method by which the defendants' alizarine was manufactured; and, if so, when, where, and how did you acquire that personal knowledge?

A. I have no personal knowledge of their mode of manufacture.

113 x-q. 42. Is there any practical difference, for the purposes for which calicos are used, in respect to the fastness of color, whether they are dyed with madder alizarine or with anthracene alizarene?

A. I cannot state precisely as to the relative fastness of anthracene alizarine and the alizarine which may be made from madder, because there is no pure madder alizarine to be found in the market, and I have not had time to prepare a pure madder alizarine.

x-q. 43. Is there any practical difference in the fastness of colors in calicos, for the purposes for which they are manufactured, whether they are dyed with the madder alizarine of commerce or with the anthracene alizarene of commerce? I am not asking about chemically pure alizarine in either case.

A. There is a difference, and in respect to one of the alizarines of commerce—namely, Kopp's green alizarine—the difference is very decided with respect to the fastness of the colors and the beauty of the tints.

x-q. 44. Is the alizarine described in the patent green alizarine?

A. I believe there is no alizarine described in the patent. I believe the patent simply speaks of artificial alizarine, or in one case of alizarine used as a generic term, without any prefix.

x-q. 45. The patent states: "We then dissolve it in water and filter the violet solution, from which we precipitate the alizarine by inorganic acid. We collect the yellow flocks of alizarine thus obtained on a filter and wash them with water." Now, if you will do me the favor to accept that statement as true, notwithstanding your opinion to the contrary, the question I wish answered is, whether the substance there described, whatever you may think it is, is green alizarine?

A. Before answering the question I wish it to be distinctly understood that I have not said anything whatever which implies that I do not believe that they have stated what is true in their specifications. Then, coming to the question itself, it is perfectly plain to any one that green alizarine is not meant; but the context plainly shows that what is meant is an artificial alizarine, so called, which is obtained from anthracene.

x-q. 46. Won't you consent to the statement of the patent that the process there described produces yellow flocks of alizarine; and, if you refuse to consent to that, will you be good enough to tell the court what is the color of the precipitate there described?

A. Of course I believe that what is produced in this process is a substance in the form of yellow flocks.

x-q. 47. Now, is it not also true that in the arts there is a madder extract, or a substance produced from madder, whose color is yellow, whose general appearance is similar to the yellow flocks described in the patent, which is used for dyeing calico?

114 A. I have never seen any such substance, nor am I aware that any such has appeared in this country.

x-q. 48. What is the color of the madder extracts used in dyeing?

A. It is red, with an inclination to orange, and it is entirely different from such artificial alizarine as I have seen.

x-q. 49. Is there no madder dye-stuff that is yellow and which is used for dyeing calico?

A. Not to my knowledge.

x-q. 50. What is the color of a decoction of madder?

A. It depends on the kind of madder. The Dutch madder contains a great deal of yellow material which performs no office in dyeing, and the Dutch madder makes a dirty orange decoction, while French madder and Turkish madder make a decoction which inclines more to red.

x-q. 51. Now, comparing calicos dyed with anthracene alizarine as it is practically used, with calicos dyed with the usual form of madder decoctions or extracts producing the same or similar colors, is there any practical difference for the purposes of clothing between the fastness of the colors in the two cases. If so, state the experiments by which you tried them—where the clothes were worn, who wore them, and under what circumstances they were exposed?

A. It is entirely unnecessary to make prints into clothes to test the fastness of colors. I have made experiments which show that for the purposes of clothing the prints made with artificial alizarine will stand exposure to destructive agents very much better than those made with the ordinary preparations of madder. Among the exhibits which I have already introduced in this case are specimens I have dyed in Boston, in the laboratory of the Massachusetts Institute of Technology, with three specimens of artificial alizarine, with flowers of madder, with garancine, and with two specimens of extract of madder. A portion of these exhibits have been boiled with soap, another portion have been exposed to the action of an oxydizing agent and with caustic alkali, so that I have been able to gain a good idea of the effects which would be produced on such prints by repeated washings and long exposure in the wet state to the action of air and light. The result of these experiments is a conclusive proof that the preparations of madder will not resist severe treatment by any means as well as prints dyed with artificial alizarine.

x-q. 52. Is it not true then that fast colors are produced practically for all the purposes of clothing by the use of madder?

A. It is true that the madder prints are faster in their colors than those produced with other natural dye-stuffs.

x-q. 53. Question repeated.

A. Fast is a comparative term, and if you wish me to answer
115 the question in different words from those which I have already answered it, I must ask you to define what you mean by the term fast.

x-q. 54. You being a calico printer, must be assumed to know what that term means better than I do. The question I wish answered

is whether madder-dyed goods cannot be made so as to practically fulfill the guarantee given by the printer that the colors are fast? I don't ask whether they can be destroyed by powerful reagents such as a chemist in a laboratory could apply to them, nor whether they change so that the variation can be detected by scientifically constructed instruments, but whether they are not practically fast for all purposes of clothing?

A. The goods dyed with madder may properly be guaranteed by the manufacturer as fast colors, as he, thereby, means what I have already stated in my answer—those which are more permanent than those produced by most other dye-stuffs.

x-q. 55. Do you mean to tell the court that the use of anthracene alizarine has established a new commercial and practical standard of fastness in colors, so that madder-dyed goods are no longer considered fast, while anthracene goods are? If so, what printing establishment or what commercial establishment recognize that standard, and sell goods according to it?

A. I should not tell the court that any such commercial distinction has as yet been established, and there are some reasons why it is not likely to be established for some time to come.

x-q. 56. Do you mean to tell the court that two pieces of calico of the same pattern and quality in other respects, the one being dyed with anthracene alizarine and the other with madder alizarine, would be so practically different in respect to the fastness of the colors that, for the ordinary purposes of clothing, they would have different values in the market?

A. I have no idea that of two pieces dyed, of the same pattern, one with artificial alizarine and the other with any of the preparations of madder, the one dyed with artificial alizarine would command any higher price in the market for the reason that it takes some time for the consumers to find out that the one is better than the other.

x-q. 57. Is it your opinion that one is so much better than the other in respect to fastness of colors that, for purposes of clothing, it ought to command a higher price than the other, and if so, state the experiments you have tried or seen tried that leads you to that conclusion?

A. It is my opinion, and it is based on the experiments which I have already mentioned, which furnish a practical test that may be made in a few hours, as to the effect of such agencies as ordinarily act on calicos week after week until the colors are gone.

116 x-q. 58. Is it your opinion that the colors of anthracene alizarine are absolutely fast, and will not fade under any circumstances?

A. It is not.

x-q. 59. Did you discover the difference in fastness before you were employed in this case and tried your laboratory experiments?

A. I did not.

x-q. 60. As far as you know, has that difference been discovered

to be a practical difference in trade or in commerce; if so, where is any such statement found, or who is your authority for any such proposition, if you make it?

A. I am not aware that the full advantages of artificial alizarine have as yet been recognized in trade or in commerce, and the method which I have used for testing is one which has been but recently proposed, the first mention of it being made in the *Bulletin of the Industrial Society*, at Mulhouse, for February and March, 1876.

Re-direct:

Re-q. 61. You were asked in cross-question 44 whether the alizarine described in complainants' patent is green alizarine; please state more fully whether green alizarine is described in said patent?

A. In my answer to cross-question 44 I should have stated, "I believe there is no *green* alizarine described in the patent." Green alizarine is an article which appeared in the market some years ago, and was an impure substance obtained from a decoction of fresh madder; there has never been any other article called green alizarine.

Re-cross:

Re-x-q. 62. Have you not intended to say in this examination that the patent did not describe alizarine at all?

A. I have intended to say that the patent did not describe chemically pure alizarine.

Re-x-q. 63. Did you suppose that when alizarine was spoken of generally in the art as a dye-stuff, chemically pure alizarine was intended?

A. I did not. The term alizarine has been used somewhat ambiguously, and I have taken pains to define it as far as I could.

JOHN M. ORDWAY.

Attest: JOHN G. STETSON, *Examiner.*

117 *Deposition of James Harley.*

Direct examination by J. Van Santvoord, esq., of counsel for complainants.

BOSTON, *Dec.* 5, 1876.

Q. 1. Please state your name, age, residence, and occupation.

A. James Harley; 40; Lowell, Mass.; calico printer.

Q. 2. How many years have you been a calico printer, and where, and in what capacity?

A. I have been connected with calico printing for twenty-four years; in Scotland, for many years, in the capacity of color mixer; in London, for several years, in the capacity of color mixer and manager of print works, and in the United States, with the Hamilton Woolen Company at Globe village, Mass., for a year and a half, as color mixer, and with the Hamilton Manufacturing Company in

Lowell, Mass., about nine years, as assistant superintendent and color mixer. My connection with the last-named company terminated about nine months ago.

Q. 3. Describe briefly your duties as color mixer and as assistant superintendent of the Hamilton Manufacturing Company.

A. My duties as assistant superintendent were to promote the interests of the company, and as color mixer to produce the required effects on calicos in colors.

Q. 4. Please describe more particularly what you mean by the expression "to produce the required effects on calicos in colors;" what did you have to do for that purpose?

A. I had to mix the colors to put on the cloth. There were certain patterns shown as designs and colors to go by, and my business was to produce those colors and effects on the cloth. I took the different drugs that I considered best to produce a certain effect, mixed those drugs in the shape of color, and gave them to the printer to put on the cloth, and saw that the proper result was attained.

Q. 5. What styles of calicos did you produce chiefly at the Hamilton Manufacturing Company's works?

A. Madder styles.

Q. 6. What dye-stuffs did you chiefly use for producing those madder styles?

A. Madder, garancine, sumac, in different proportions.

Q. 7. What is garancine?

A. A preparation of madder.

Q. 8. Did you use any other dye-stuffs besides those you have named for producing madder styles?

A. Yes, sir.

118 Q. 9. What other dyestuffs?

A. Extract of madder and artificial alizarine.

Q. 10. What is extract of madder?

A. Coloring matter derived from madder.

Q. 11. How did you use garancine for producing the madder styles?

A. The mordant or mordants were first printed on the cloth, then aged and passed through silicate of soda, or arseniate of soda, or both. Then the goods were put into a dye beck or bath along with the garancine, and dyed to the required shade.

Q. 12. How did you use madder extract for that purpose?

A. In combination with the mordants as a topical color, then submit it to steam, afterwards soaped.

Q. 13. How did you find the madder extract to work for that purpose?

A. Two difficulties presented themselves, one was grit in the color, and the other, that it stuck in the engraving.

Q. 14. Please explain more fully to what you refer by the expression, "it stuck in the engraving," and what it is that "stuck in the engraving." Please state fully and particularly to what you refer.

A. The extract of madder filled the engraving, consequently we

could not get the impression of the engraving on the cloth. As the component parts of the color are starch, acetic acid, and extract of madder, acetate of alumina and acetate of lime, and neither of them except the extract of madder will stick in the engraving of themselves, consequently we came to the conclusion that it is the extract of madder that sticks in the engraving.

In working the color we found that we could only print an amount of pieces that would make it almost impracticable to work it, from the fact that it took the edge off of the printers' doctor, and necessitated the stopping of the machine, and consequently we abandoned the use of extract of madder.

Q. 15. How did you use artificial alizarine for this same purpose, and state how that worked?

A. We used it practically in the same way. We never had any difficulty with it whatever.

Q. 16. To what method of calico printing do you here refer?

A. What is known in the print business as topical printing.

Q. 17. Did you also use at the Hamilton Print Works artificial alizarine in dyeing madder styles?

A. Yes, sir.

Q. 18. How did you use it for that purpose?

A. Usually in combination with garancine, sumac, and other dyestuffs, such as Persian berries and flavine, to obtain fine results such as are required on styles known as robe styles.

119 Q. 19. How did you find that artificial alizarine worked for that purpose?

A. We got better results from it in combination with garancine than we could get by garancine alone.

Q. 20. How, then, in your opinion does artificial alizarine compare with garancine and with madder extract for producing good results in topical printing and in dyeing calicos; which is superior for those purposes?

A. In my experience I have always got better results from artificial alizarine than I could get from madder, garancine, or extract of madder.

Q. 21. How long have you used artificial alizarine as a dyestuff?

A. I am not prepared to give any date, but since the first introduction of it into this country, say five or six years.

Q. 22. Have you used much of it as a dyestuff while at the Hamilton Print Works?

A. Yes, sir.

Q. 28. Have you found any considerable variation in the quality of the artificial alizarine you have used?

A. We have found a little variation in the quality.

Q. 24. Did this artificial alizarine which you used at the Hamilton Print Works prove pretty uniform in quality?

A. Yes, sir.

Q. 25. From whom was the artificial alizarine obtained which you used at the Hamilton Print Works, if you know?

A. I don't know. I didn't buy the stuff, and was only there to use it.

Q. 26. Did you understand from what different sources the artificial alizarine used by that company was obtained; and if so, what was your understanding as to this matter?

A. While in the employment of the Hamilton Company I have used artificial alizarine designated as Pickhardt & Kuttroff's, and artificial alizarine designated as Cochrane's.

Q. 27. How did the artificial alizarine designated as Cochrane's compare in quality with that designated as Pickhardt & Kuttroff's?

A. We found Pickhardt and Kuttroff's to give a little the best result.

Q. 28. State whether or not the use of artificial alizarine as a dyestuff in this country is increasing.

A. In my opinion it is.

Q. 29. What effect has the introduction of artificial alizarine into use as a dyestuff had upon the use of madder and preparations of madder as dyestuffs?

A. It has diminished the use of them in print works.

Q. 30. What effect has the introduction of artificial alizarine into use as a dyestuff had upon the manufacture of calicos?

120 A. It has enabled printers to produce effects that could not be obtained by the use of garancine or madder.

Q. 31. State whether or not it has enabled printers to improve calicos, and if so, in what respects?

A. Calicos have been improved by the use of artificial alizarine by introducing brighter shades of color, better whites than by the use of garancine or madder, and the work produced more expeditiously.

Q. 32. You have said in answer to interrogatory 18 that you have used artificial alizarine in combination with garancine and other dye-stuffs; state whether or not you could have obtained equally good results by using artificial alizarine alone?

A. I could have obtained as good results by using artificial alizarine in place of garancine with other dye-stuffs, such as Persian berries, sumac, and flavine; in fact I could have obtained better results.

Q. 33. Then why did you combine the garancine with the artificial alizarine instead of using the artificial alizarine without the garancine?

A. The price of the artificial alizarine stood in the way of its being generally used, notwithstanding its giving better results.

Q. 34. What is the strength in dyeing properties of artificial alizarine as compared with garancine?

A. From experiments that we have made we have found one pound of artificial alizarine equal to four pounds and a half of commercial garancine.

Q. 34. What brand or quality of garancine was it with which you made this experiment?

A. The brand known in the market as "Lion A." It is considered a good quality.

Q. 35. Will you please examine these eight swatches which have been dyed by Prof. Ordway with different samples of artificial alizarine, and which are marked "g" "d" "pb" "10" "g^1" "d^1" "pb^1" and "10^1" respectively, the last four of which have been soaped, while the first four have only been washed with water, and give your opinion as to the comparative goodness of the shades of color of said swatches?

A. pb^1 is the best, g^1 is very close to it, d^1 is the next, and then 10^1. Those which have been washed with water only stand in the same relation to each other, namely, pb, g, d, 10. The three first I have named in each series stand very near to each other.

(The cross-examination of this witness is reserved.)

JAMES HARLEY.

Attest: JOHN G. STETSON,
Examiner.

121 NEW YORK, FRIDAY, *Dec. 8th*, 1876.

Present: John Van Santvoord, esq., counsel for complainant; E. N. Dickerson, esq., counsel for defendants.

JAMES HUNTER, called on the part of the complainant and duly sworn, deposes and says:

Question 1. What is your name, age, residence, and your profession or occupation?

Answer. James Hunter; 53 years of age; reside at Philadelphia, and a calico printer.

Q. 2. How many years have you been a calico printer, and where, and in what capacity?

A. Over 30 years, in Philadelphia; I have been engaged in nearly all the occupations in the print-works, and as proprietor over 25 years.

Q. 3. As proprietor have you been and are you accustomed to superintend and direct the details of the work carried on in your establishment?

A. I keep a general supervision of all the details of the work, and especially if any changes are to be made in the mode of operation, both in the dye-stuffs and chemicals employed, as well as in the machinery department. I give the necessary directions myself, and see that they are carried out.

Q. 4. What styles of calico do you produce chiefly at your works?

A. Principally madder styles.

Q. 5. What dye-stuffs do you chiefly use for producing these madder styles?

A. Garancine, sumac, preparations of bark, madder extract, and artificial alizarine; also logwood and catichue.

Q. 6. What is garancine?

A. A preparation of madder.

Q. 7. What is extract of madder?

A. Another preparation of madder, the coloring matter of madder, freed from woody fibre and other impurities as much as possible.

Q. 8. How do you use garancine?

A. For dyeing the goods. After they had been mordanted and aged and freed from the surplus mordant, the goods are introduced into the dye-bath with the garancine and other dyeing materials, such as sumac, bark, etc.

Q. 9. How do you use madder extract in producing madder styles?

A. Principally by what is known as topical printing—by mixing the coloring matter and mordants with suitable thickening, then printing on the goods and steaming, afterwards washing off and soaping.

Q. 10. How do you use artificial alizarine for producing madder styles?

122 A. Both in the dye-bath mixed with other coloring matters as I have described in the case of garancine and also in topical printing, just as I have described with madder extract.

Q. 11. How did you find artificial alizarine work under these circumstances?

A. It worked very well.

Q. 12. Did you ever dye with extract of madder?

A. Only as a matter of experiment.

Q. 13. As a result of such experiment how did you find the extract of madder to compare with artificial alizarine as a dye-stuff?

A. I prefer the artificial alizarine for use in the dye-bath.

Q. 14. How did the extract of madder compare with artificial alizarine in topical printing?

A. For some patterns I prefer madder extract, and for other patterns I prefer artificial alizarine.

Q. 15. How did garancine compare with artificial alizarine when used in the dye-bath?

A. For most bright colors I would prefer the artificial alizarine, and for dark colors I think there is no difference.

Q. 16. Taken altogether which do you consider the more desirable—artificial alizarine or madder preparations?

A. Irrespective of price I would prefer artificial alizarine.

Adjourned to 2 p. m.

2 o'clock p. m.

Q. 17. You state, in answer to question 14, "For some patterns I prefer madder extracts and for other patterns I prefer artificial alizarine;" please state fully and particularly for what reasons you prefer one or the other material in different cases.

A. The extract of madder does not seem to be so sensitive to injurious action from other colors which may be worked with it as the

artificial alizarine; on the other hand, the artificial alizarine being free from woody fibre and resinous substances that are contained more or less in madder extract, it works smoother and better in some patterns.

Q. 18. Have you made garancine at your works, and if so, in what quantities?

A. We have made it—many hundreds of casks of madder into garancine.

Q. 19. Have you made madder extracts, and if so, in what quantities?

A. We have made hundreds of casks of madder into extract of madder.

Q. 20. How long have you used artificial alizarine as a dye-stuff?

A. We tried it about six years ago, and have used it more or less since then.

123 Q. 21. From whom did you obtain the first artificial alizarine you used?

A. From Mr. Wm. Pickhardt about six years ago.

Q. 22. What effect has the introduction of artificial alizarine into use as a dye-stuff had upon the use of madder and preparations of madder as dye-stuffs?

A. It has had the effect to reduce the price of madder and madder extract very much, and has diminished the use of them in print works. In my own case where I manufactured large amounts of madder extracts for our own use and for sale we have now ceased to manufacture, and use the artificial alizarine instead. Formerly I used large quantities of madder and garancine for dyeing madder styles. At the present time three-fourths of our madder styles are made by topical printing, so that our dye-becks are not used at all during about nine months of the year.

Q. 23. What effect has the introduction of artificial alizarine into use as a dye-stuff had upon the manufacture of calicos?

A. It has reduced the cost of production of calicos, and it has improved the styles and coloring.

Q. 24. What was the average price of madder before the introduction of artificial alizarine?

A. About ten to twelve cents gold per pound.

Q. 25. What is about its present price?

A. I believe it is from four and a half to five cents per pound, gold.

JAS. HUNTER.

Subscribed and sworn to before me, this 8th day of December, 1876.

R. E. STILWELL,
Examiner.

Cross-examination waived by Mr. Dickerson.

NEW YORK, *Dec. 9th*, 1876.

Present: John Van Santvoord, esq., solicitor for complainants; E. N. Dickerson, esq., solicitor for defendants.

Mr. CARL PICKHARDT, being called and duly sworn on the part of the complainants, deposes and says:

Question 1. What is your name, age, residence and occupation?

Answer. My name is Carl Pickhardt; my age is 25 years; I reside at No. 51 West 55th street, New York city, and a chemist by profession.

Q. 2. What opportunities have you had of rendering yourself familiar with the science of chemistry or with any of its practical applications?

A. I studied chemistry for two years—principally relative to dyes and dye-stuffs, under Prof. Rosensthiel at the "Ecole des sciences appliquées," at Mulhouse.

124 Q. 3. Where did you study previously to this?

A. I studied at a private institution.

Q. 4. Have you read and do you understand the patent No. 4321, Complainants' Exhibit A?

A. I have read it, and think I understand it.

Q. 5. Have you ever made artificial alizarine according to the directions contained in said patent?

A. I have made it several times.

Q. 6. How many times have you made it?

A. I made six operations.

Q. 7. What quantity of product did you obtain, about, at each operation?

A. Enough to dye one or two yards of ordinary calico.

Q. 8. The first time you tried to produce artificial alizarine according to the directions of this patent, were you successful, or not?

A. I was successful, and obtained a product which showed a very good color on mordanted cloth.

Q. 9. Did you ever fail in producing a good result?

A. In the second operation I produced a less good product, during my absence at the critical moment; it seemed to have decomposed partly again.

Q. 10. Please state more fully the circumstances attending the production of this inferior product?

A. While I took out a sample and dissolved it in water, to see whether the operation was finished, I left the laboratory to show the solution, which was very handsome, to my brother; when I returned to dissolve the entire product, I found it partly decomposed.

Q. 11. How was it with the operations of making artificial alizarine according to the directions of this patent which you have conducted since—were they successful, or not?

A. They were successful, and I always obtained a good result.

Q. 12. Please state what you did with each one of the products heretofore referred to?

A. I used of the products of operations No. 1 and 3, sufficient to make dyeing tests; then I mixed products 1 and 3 and sent them, by express, to Prof. John M. Ordway, Boston, Mass. I used also enough of products of the operations 4, 5 and 6 to make dyeing tests; then mixed them and handed one-half of the products to my brother to give them to Prof. Ordway.

Q. 13. In what manner did you send the products 1 and 3, or what remained of them after you had used a portion for dyeing tests, to Prof. Ordway? please state fully and in detail.

A. I had them put up, in my presence, in a box which was sealed, then put in another box, and addressed to Prof. John M.
125 Ordway, Massachusetts Institute of Technology, Boston, Mass.—Private.

Q. 14. Did you put up, or cause to be put up, anything else in the same box?

A. I have a memorandum of what I put in the box, but I cannot remember now.

Q. 15. Did you seal the box yourself, and did you take any means to enable Prof. Ordway to identify the seal?

A. I did seal it myself, and sent Prof. Ordway a copy of the private seal which was used for sealing the box.

Q. 16. When you say a copy of the seal, do you mean an impression in wax, or something else?

A. I sent him an impression of the same seal in sealing wax.

Q. 17. And how was this sent?

A. In a letter by mail.

Q. 18. Did you receive from Prof. Ordway an acknowledgment of the receipt of said box in perfect condition?

A. I received an acknowledgment from Prof. Ordway that he did receive it in perfect condition.

Q. 19. Have you made any dyeing tests with artificial alizarine and with madder preparations applied to woolen cloth?

A. I have made such tests.

Q. 20. Please produce specimens of the cloth so dyed, and describe them.

A. I produce them, and they are respectively marked 1, 2, 3 and 4. The cloth for all four exhibits was prepared when in one piece. No. 1 was dyed with Meissonier's madder extract. No. 2 was dyed with garancine, V. C. No. 3 was dyed with artificial alizarine of complainants. No. 4 was dyed with artificial alizarine, Exhibit Browne No. 1.

Q. 21. Comparing the two exhibits dyed with artificial alizarine Nos. 3 and 4, what resemblance or difference do you find between them?

A. They seem to be nearly alike. No. 3 showing a little deeper color.

Q. 22. Comparing the two exhibits dyed with preparations of mad-

der with each other, what resemblance or difference do you find between them?

A. They resemble each other very much. Exhibit No. 2 being the deeper color.

Q. 23. Comparing the pair of exhibits dyed with artificial alizarine, i. e., Exhibits 3 and 5, with the pair dyed with preparations of madder, i. e., Exhibits 1 and 2, what resemblance or difference do you find between these two pairs?

A. There is no resemblance in the colors of the two pairs of exhibits.

Q. 24. How would you describe the colors of the exhibits?

126 A. Exhibits 1 and 2 are a scarlet color, Exhibits 3 and 4 are of a dirty yellow color.

Q. 25. To what do you attribute this difference of color in the dyed cloth?

A. They show a difference of composition of coloring matters.

Q. 26. Has such a difference in the behavior of artificial alizarine and preparations of madder with woolen fabrics been noticed before?

A. It has been so stated in Napier's Manual of Dyeing and Dyeing Receipts, London, 1875, page 335, from which I read: "Notwithstanding this, artificial alizarine will not put madder quite out of the market, for the latter is preferable for many colors on wool because it contains other dyes which the wool takes up, giving tints which pure alizarine does not. But further discoveries may soon overcome this difference." It has also been stated to me by woolen manufacturers in this country.

Q. 27. Have you heard anything to the same effect elsewhere?

A. Dr. Caro told me the same thing in August, 1876.

(Counsel for complainant offers in evidence the exhibits referred to, and they are marked respectively Exhibits 1, 2, 3 and 4; R. E. S., examiner.)

Q. 28. In making artificial alizarine, as you have already testified, did you make any variations in the quantities of caustic soda or potash employed in the final heating and in the temperature at which this part of the process was carried on within the limits set forth in the patent, and if so, had such change any effect, and if any, what effect upon the character of the product?

A. I did vary the porportions of caustic potash, using between two and three parts to one part of bibromanthrachinone; also a difference in the heat. I find a larger proportion of caustic potash and a higher temperature to give me a product which dyes mordants a redder color, while a lower temperature and less caustic potash gives a product which dyes mordants a more bluish shade.

Q. 29. Question and answer 25 read as follows: "Q. To what do you attribute this difference in color of the dyed cloth? A. They show a difference of composition of coloring matters." Please explain more fully what you mean by the words "a difference of composition of coloring matters."

A. I mean the madder preparations contain some coloring matters which are not contained in artificial alizarine.

Q. 30. Having sent for your letter-book, will you please with its aid as a memorandum state what materials you placed in the box which you have testified to having sent to Prof. Ordway?

A. I sent:

One bottle—one half pound flowers of madder;
127 One bottle—one half pound of garancine V C;
One bottle—Pinkoff's alizarine or purple garancine;
One bottle—one half pound madder extract, Messonier's;
Two bottles—alizarine chemically pure, one in crystals and one in paste, from Prof. Morton;
One bottle—artificial alizarine, made from bibromanthrachinone by Carl Pickhardt;
One bottle—Cochrane's artificial alizarine Exhibit Browne No. 1, handed to me by Prof. Morton;
One bottle—one pound B A & S F artificial alizarine V D;
One bottle—one pound B A & S F artificial alizarine D;
Two yards mordanted cloth.

Q. 31. In your last answer when you say, "one bottle artificial alizarine made from bibromanthrachinone by Carl Pickhardt," do you intend to indicate thereby the products of the first and third operation for making artificial alizarine referred to by you in your answer to question 12?

A. Yes, sir.

CARL PICKHARDT.

Subscribed and sworn to before me this 9th day of December, 1876.

R. E. STILWELL,
Examiner, &c.

The cross-examination of this witness is reserved.

R. E. STILWELL,
Examiner, &c.

NEW YORK, *Jan.* 3*d*, 1877.

Continuation of examination of CARL PICKHARDT.

Present—J. Van Santvoord, esq., for complainants; E. N. Dickerson, esq., for defendants.

Q. 32. On what day did you send to Prof. Ordway the articles mentioned in your answers 12 and 13 and 30?

A. I sent them in a box on the 20th of November, 1876, by Adams Express.

Cross-examination waived by defendants' counsel.

CARL PICKHARDT.

Subscribed and sworn to before me this 3d day of Jan'y, 1877.

R. E. STILWELL,
Examiner, &c.

128 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et at. } In equity.

United States Circuit Court, district of Massachusetts.

SAME
vs.
HAMILTON MANUFACTURING COMPANY. } In equity.

It is hereby consented that the defendants in these cases have further time to put in their testimony herein to and including February 15th, 1877, and that the complainants have until March 15th in which to put in testimony in rebuttal; but this extension shall not have the effect to prevent complainants bringing on said suits for final hearing at the next February term of this court for the said southern district of New York.

Dated January 31, 1877.

J. VAN SANTVOORD,
Compl't's Sol'r.

DICKERSON & BEAMAN,
Def't's Sol'rs.

129 Circuit Court U. S., southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
ALEX. COCHRANE et al.

It is stipulated and agreed between the parties hereto that the following-named documents, inclusive of exhibits belonging thereto, may be added to the testimony heretofore taken in the above-entitled cause, and be received as evidence in the same manner and with the same effect as if they had been taken on final hearing, and that they form a part of the record for final hearing as if taken under the rule—

1. Affidavits of complainants and defendants on motion for preliminary injunction in the case of Badische Anilin and Soda Fabrik Co. *v.* Cummins, in the district of Massachusetts.

2. Affidavit of Henry Morton, dated March, 1878; affidavit of Adolf Kuttroff, dated March, 1878; affidavit of John D'Arcy, dated February 18, 1878; affidavit of Richard E. Stillwell, dated March, 1878, for the complainants; and the affidavits of William Bogle,

April 20, 1878; James Threlfall, April 20, 1878; Samuel W.
130 Johnson, April 20, 1878; Albert Horton, April 19, 1878; John Bracewell, April 18, 1878; Robert Henry, April 17, 1878; Henry Burrows, April 18, 1878; Thomas Walsh, April 15, 1878; James Hunter, April 17, 1878; Charles F. Chandler, April 24, 1878; Gustave Auerbach, March 25, 1878; Carl Otto Newhaus, April 6, 1878; Carl Rumpff, April 5, 1878, for defendants. Also, affidavits on rebuttal, James Harley, April 27, 1878; William Harley, April 29, 1878; Robert Sykes, April 26, 1878; John D'Arcy, April 29, 1878; John Metcalf, April 30, 1878; Thomas Kelly, April 29, 1878; James Saunders, April 30, 1878; John Wright, May 2, 1878; Benjamin C. Dean, May 2, 1878; Lewis E. Phelps, May 2, 1878; Stephen P. Sharples, May 1, 1878; John Parkhill, May 7, 1878; A. B. Mole, May 7, 1878; Robert A. Sykes, May 7, 1878; James Sanders, May 8, 1878; John Metcalf, May 8, 1878; Thomas Smith, May 8, 1878; Philip L. Fowler, May 9, 1878; Thomas Longshaw, May 7, 1878; Charles E. Wild, May 8, 1878; William Harley, May 9, 1878; Peter McTague, May 10, 1878; James Harley, May 10, 1878; Arno Behr, May 13, 1878; John M. Ordway, May 13, 1878; Adolf Kuttroff, May 13, 1878; Stephen P. Sharples, May 13, 1878; Henry Morton, May 13, 1878; Carl Pickhardt, May 13, 1878; William E. Geyer, May 13, 1873.

Also affidavits of defendants on the motion for rehearing in this case, viz.: of G. Auerbach, July 5, 1878; Charles Hunter, Aug. 29, 1878; P. Römer, Aug. 5, 1878; E. Schüler, Aug. 5, 1878; Gustav Auerbach, Aug. 22, 1878; August Viefhaus, June 19, 1878; Adolph Gauhe, August 29, 1878; Ernst Schlbach, June 21, 1878; August Römer, July 30, 1878; Charles F. Chandler, November, 1878; C. Howland, November, 1878.

Also affidavits of complainants in opposition thereto, viz.: Wilhelm Pickhardt, November 18, 1878; Henry Morton, November 18, 1878; John M. Ordway, November 14, 1878; Carl Pickhardt, November 18, 1878.

Also affidavits of Wilhelm Pickhardt, December 2, 1878;
131 Henry Morton, December 2, 1878; John M. Ordway, December 3, 1878; Arno Behr, December 2, 1878; Carl Pickhardt, December 2, 1878.

Also examination and cross-examination of Henry Morton in the case of Badische Anilin Co. *v.* Cummins, in the district of Massachusetts.

Also the following exhibits put in by the defendants: Papers read before Chemical Society in Berlin in 1868 and 1869, by Graebe and Liebermann; also English provisional specification of Graebe and Liebermann, patent of 1868; also English patent of 1868; also United States patent of 1869; provisional specification English patent of 1869; English patent Caro and Graebe and Liebermann, 1869; also reports of Graebe and Liebermann at Vienna exhibition of 1873, imprint of 1876; also American patent of Caro and Graebe and Liebermann, July 28, 1874, "Neues Handwörterbuch der Che-

mie, vol. I., No. 3, Braunschweig, 1871," including also the extracts from publications referred to by Mr. Wilhelm Pickhardt in his affidavits hereinbefore mentioned. Either party may refer to the record in the case of Badische Anilin and Soda Fabrik *v.* James Higgin & Co., where the affidavits herein refer to the same.

The testimony of witnesses shall be taken subject to any objection as to its competency which might have been taken before the examiner, but no objection shall be taken to the form of the affidavits.

J. VAN SANTVOORD,
Compl'ts' Solr.

DICKERSON & BEAMAN,
Solicitors for Defendants.

Rutland, Vt., Dec. 6, 1878.

132 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

To Messrs. DICKERSON and BEAMAN, def'ts' sol'rs:

Please take notice that on the eleventh day of March, 1878, at eleven o'clock in the forenoon of that day, or as soon thereafter as counsel can be heard, at the court-room of the said court, in the city of Boston, in said district, we shall move said court or one of the judges thereof, on the bill of complaint herein, and upon the affidavits of Adolf Kuttroff, John D'Arcy, Henry Morton and Richard E. Stilwell, the decree of said court of February 4th, 1878, in the suit of said complainants against Hamilton Manufacturing Company, defendants; the opinion delivered by his honor, George F. Shepley, circuit judge, in deciding said suit; the letters-patent of the United States, reissue No. 4321, dated April 4th, 1871; and the assignment thereof by the patentees of said patent to said complainants, and the certificate of incorporation of said complainants under the laws of the Grand Duchy of Baden, copies whereof are hereto annexed and herewith served upon you, and such other papers as may be served upon you, for an interlocutory injunction against the said defendant, Thomas K. Cummins, enjoining and restraining said defendant and all persons acting under him from making, using, or selling, directly or indirectly, the invention secured by said reissued letters patent as prayed for in said bill during the pendency of this suit, and until the further order of the court herein, and for such other or further order or relief as to the said court shall seem meet.

Dated March sixth, 1878.

J. VAN SANTVOORD,
Compl'ts Sol'r.

GEORGE GIFFORD,
Of Counsel.

133 In the Circuit Court of the United States, district of Massachusetts.—In equity.

To the honorable the judges of the Circuit Court of the United States for the district of Massachusetts:

"Badische Anilin and Soda Fabrik," a corporation organized under the laws of the Grand Duchy of Baden, in the Empire of Germany, and doing business at Manheim, Stuttgart, and Ludwigshafen, in said Empire of Germany, bring this their bill of complaint against Thomas K. Cummins, defendant, doing business under the name or style of Thomas K. Cummins & Co., at Boston, in said district of Massachusetts.

And thereupon your orators complain and say, upon information and belief, that heretofore and before the fifth day of October, 1869, Charles Graebe, of Frankfort-on-the-Main, being then a citizen of the United States, and Charles Liebermann, of Berlin, Prussia, being then a citizen of Prussia, were jointly the first and original inventors and discoverers of a certain new and useful improvement in dye-stuffs, described in the letters patent dated October 5th, 1869, hereinafter mentioned, and which was not known or used by others prior to their invention thereof, and which was not and had not been at the time of their application for letters patent therefor, as hereinafter mentioned, in public use or on sale with their consent and allowance, contrary to the provisions of the statutes of the United States in such case made and provided, and had not been in public use or on sale for two years prior to their said application.

That said Graebe and Liebermann being so as aforesaid the first and original inventors and discoverers of the said improvement, and being desirous to obtain an exclusive property in said invention or improvement, within and for the United States, did on the fifth day of October, 1869, upon due application therefor, and having in all things complied with the conditions and requirements of the acts of Congress in such case made and provided, obtain letters patent of the United States for said invention or improvement, in due form of law, under the seal of the patent office of the United States, signed by the secretary of the interior and countersigned by the commissioner of patents, bearing date the said 5th day of October,
134 1869, and numbered 95465, which said letters patent are now remaining of record in the patent office of the United States, by which said letters patent there was granted and secured or intended to be granted and secured to them, their executors, administrators, or assigns, for the term of seventeen years from the said 5th day of October, 1869, the full and exclusive right and liberty of making, using, and vending to others to be used the said invention or improvement described in said letters patent, and by virtue thereof they became and were the sole owners of all the rights and privileges granted and secured or intended to be granted and secured in and by said letters patent.

And your orators further show unto your honors that the said

Charles Graebe and Charles Liebermann having, for good and lawful cause, after the issuing of the said letters patent as aforesaid, surrendered the same to the commissioner of patents, and having made due application therefor, and having in all things complied with the requirements and conditions of the acts of Congress in such case made and provided, did, on the 4th day of April, 1871, obtain new letters patent, numbered 4321 of reissued letters patent, for a distinct and separate part of the same invention, on a corrected specification, for the residue of the said term of seventeen years from the fifth day of October, 1869, which said reissued letters patent were issued in due form of law, under the seal of the patent office of the United States, signed by the acting secretary of the interior, and countersigned by the commissioner of patents, bearing date the said 4th day of April, 1871, and numbered 4321 of reissued letters patent, and which said reissued letters patent are now remaining of record in the patent office of the United States, as by said letters patent, or a duly authenticated copy thereof, in court ready to be produced, will fully and at large appear.

And your orators further show unto your honors, that afterwards, and on or about the 1st day of March, 1872, the said Charles Graebe and Charles Liebermann did, by an assignment in writing, duly signed, executed and delivered, and bearing date the 1st day of March, 1872, sell, assign and transfer unto your orators, along with other things, all their, the said Graebe and Liebermann's, rights, title and interest in and to said letters patent, reissue No. 4321, so as aforesaid granted to them, and in the invention described therein, and secured or intended to be secured thereby, which said assignment was duly recorded in the patent office of the United States, on the 28th day of March, 1872, in liber I[15] of Transfers of Patents, page 260, as by said assignment, or a duly authenticated copy thereof, together with the certificate of the recording thereof, here in court ready to be produced, will fully and at large appear, and by virtue of which assignment your orators became and now are the sole owners of all the rights and privileges granted and secured, or intended to be granted and secured in and by said letters patent so granted as aforesaid, on the said 4th day of April, 1871.

And your orators further show that by reason of the premises, your orators have been ever since the said 1st day of March, 1872, and are exclusively entitled to use, exercise and enjoy all the exclusive rights, privileges, profits and advantages granted and secured, or intended to be granted and secured, in and by said reissued letters patent 4321, for and during the term of years in said reissued letters patent mentioned.

And your orators further show unto your honors that the said invention or discovery, so patented as aforesaid, and assigned unto your orators, is very valuable and useful to the public, and that the same has been extensively introduced into public use, and that the public have generally acquiesced in your orators' exclusive right to

the same; and your orators would, but for the wrongful acts of the said defendant, and others acting in concert with him, have made large gains and profits from the manufacture, use and sale of the said invention, which they have been and are now hindered from making by reason of said wrongful acts of the said defendant.

And your orators further show unto your honors, upon information and belief, that the said defendant, Thomas K. Cummins, well knowing the premises, and the rights and privileges secured unto your orators, and in order to deprive them of the profits, benefits and advantages which might and otherwise would have accrued to them at the city of Boston aforesaid, and elsewhere, and within the said district of Massachusetts, and without the license or permission of your orators, has, ever since the 1st day of March, 1872, and at divers times since that time, and before the commencement of this suit, unlawfully and wrongly made, or caused to be made, sold or caused to be sold, used or caused to be used, said invention and dyes or coloring matter, containing the said invention or discovery and improvements, or substantial or material parts thereof, described and patented in the said reissued letters patent, number 4321, the exclusive right to which is secured to your orators, as hereinbefore set forth, and which said unlawful making, use and sale by the defendant as aforesaid, are a violation and infringement of your orators' exclusive rights and privileges, under the reissued letters patent as aforesaid, and that the said defendant still continues so to do, in defiance of your orators' said rights and privileges, and to your orators' great and irreparable loss and injury, and by which your orators have sustained and been put to great loss and damage, and have been and still are deprived of great gains and profits, which your orators might, and otherwise would have obtained and received, but which have been received and enjoyed and are being received and enjoyed by the
136 said defendant, by and through his aforesaid unlawful acts and doings; and that the said defendant has derived and received and is still deriving and receiving from such use, great gains and profits, but to what amount your orators are ignorant and cannot set forth, but your orators believe the same to be about the full sum of twenty thousand dollars, and so charge the fact to be, and pray that the said defendant may be required to make a discovery as to his use of said invention and of all gains and profits received by him therefrom, or by means thereof.

And your orators further show unto your honors, that the aforesaid using of said invention by the said defendant and his confederates, and his preparation and determination to continue the same, and the aforesaid unlawful and wrongful acts, have the effect to encourage and induce other persons to infringe and defy the letters patent as aforesaid, and the aforesaid exclusive rights and privileges of your orators.

And your orators further show unto your honors that the said defendant has been warned, and requested and notified to desist and

refrain from said infringement, and said unlawful and wrongful acts, but that said warning and request and notice have been wholly disregarded by said defendant, and that said defendant still continues the infringement, and unlawful and wrongful acts aforesaid.

And your orators pray that the said defendant may be compelled, by a decree of this honorable court, to account for and pay over unto your orators all such gains and profits as have accrued or arisen to, or have been earned or received by the said defendant, and all damages your orators have sustained, by reason of the said infringements by the said defendant.

And that the said defendant, Thomas K. Cummins, his agents, attorneys, servants and workmen, be enjoined and restrained by the order and injunction of this court, from directly, or indirectly, making or causing to be made, using or causing to be used, or vending to others to be used, said invention in any manner, or any dyes or coloring matter, containing or embodying or in any way counterfeiting or imitating the said invention described and secured in said reissued letters patent so granted as aforesaid, and from infringing upon or violating the said letters patent, by the use or sale of the said invention or of said dyes or coloring matter in any way whatever, and that all such infringing dyes or coloring matter in the possession of said defendant may be forthwith destroyed or delivered up to your orators, and that the said defendant may be decreed to pay the costs of this suit, and that your orators may have such other or further order or relief as to this honorable court shall seem meet, and shall be agreeable to equity.

To the end therefore that the said defendant, Thomas K.
137 Cummins, may, if he can, show why your orators should not have the relief hereby prayed, and may upon his corporal oath true and direct and perfect answer make, according to the best of his, or his agents, clerks, servants and workmen's knowledge, remembrance, information and belief, to the several matters hereinbefore averred and set forth, as fully and particularly as if the same were here repeated, paragraph by paragraph, and they thereto severally and specifically interrogated.

May it please your honors to grant to your orators a writ of *subpœna ad respondendum*, issuing out of and under the seal of this honorable court, directed to the said defendant, Thomas K. Cummins, commanding him, by a certain day, and under a certain penalty, to be and appear in this honorable court, then and there to make answer unto this bill of complaint, and to perform and abide by such order and decree herein, as to this court may seem meet and agreeable to equity.

And your orators will ever pray, &c.

BADISCHE ANILIN AND SODA FABRIK,
By WM. PICKHARDT, *Attorney.*

J. VAN SANTVOORD, *Complainants' Solicitor.*
GEORGE GIFFORD, *of Counsel.*

UNITED STATES OF AMERICA,
City and county of New York, } *ss.*
Southern district of New York,

WILHELM PICKHARDT, the attorney in fact of the complainants in the foregoing complaint named, being duly sworn, deposes and says that he has read the foregoing bill of complaint by him subscribed, and knows the contents thereof, and that the same are true of his own knowledge, except as to those matters therein stated on information and belief, and as to those matters he believes it to be true. And he further deposes and says that he verily believes that the said Charles Graebe and Charles Liebermann are the first and original inventors or discoverers of the invention or improvement patanted to them as set forth in said bill of complaint, and that the same has not, to the best of his knowledge, information and belief, been in use, or been described before the invention thereof by said Graebe and Liebermann; and deponent further says that his information is derived in part from his correspondence with the said complainants, who carry on business in Germany, and from his own business transactions, and those of his firm, William Pickhardt and Kuttroff, of said city of New York, with complainants; and
138 deponent further says that he has been appointed and is now the true and lawful attorney of complainants, with power to sue persons infringing said reissued letters patent in said bill mentioned.

WM. PICKHARDT.

Subscribed and sworn to before me this 22d day of September, 1876.

R. E. STILLWELL,
[L. S.] *U. S. Commissioner southern district of New York.*

No. 4321. Reissue.

The United States of America.

To all to whom these letters patent shall come:

Whereas, Charles Graebe, of Frankfort-on-the Main, and Charles Liebermann, of Berlin, Prussia, have alleged that they have invented a new and useful improvement in dyes or coloring matter from anthracene, (for which letters patent were issued to them, dated October 5, 1869, which letters having been surrendered, the same have been cancelled, and new letters ordered to issue to them on two separate amended specifications,) and have made oath, the said Graebe that he is a citizen of the United States, and the said Liebermann that he is a citizen of the Kingdom of Prussia; that they verily believe they are the original and first inventors or discoverers of the said improvement, and that the same hath not to their knowledge and belief been previously known or used; have paid into the treasury of the United States the sum of thirty dollars,

and presented a petition to the commissioner of patents praying that a patent may be issued therefor—

These are therefore to grant to the said Graebe and Liebermann, their executors, administrators or assigns, for the term of seventeen years from the fifth day of October, one thousand eight hundred and sixty-nine, the full and exclusive right and liberty of making, using and vending to others to be used, the said improvement, a description whereof is given in the annexed schedule, and made a part of these presents.

In testimony whereof, I have caused these letters to be made patent, and the seal of the patent office to be hereunto affixed.

Given under my hand at the city of Washington on this fourth day of April, in the year of our Lord one thousand eight hundred and seventy-one, and of the Independence of the United States of America the ninety-fifth.

WALTER H. SMITH,
Acting Secretary of the Interior.

Countersigned and sealed with the seal of the patent office.

M. D. LEGGETT,
Commissioner of Patents.

139 United States Patent Office.

Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin Prussia.—Improvement in Dyes or Coloring Matters from Anthracene.

Specification forming part of letters patent No. 95,465, dated October 5, 1869; reissue No. 4,321, dated April 4, 1871.

Division B.

To all whom it may concern:

Be it known that we, Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, in the Kingdom of Prussia, have invented a new and useful improvement in the manufacture of alizarine; and we do hereby declare the following to be a full, clear and exact description thereof, which will enable those skilled in the art to make and use the same.

We first change the anthracene into anthrakinon (oxanthracine,) a substance known to the chemists by the investigations of Anderson. For this purpose we take one part, by weight, of anthracene, two and a half parts, by weight, of bichromate of potash, and ten or fifteen parts, by weight, of concentrated acetic acid, and we heat these substances together in a vessel, either of glass or clay, to about 100° centigrade to 120° centigrade, till nearly all of the bichromate of the potash is dissolved and the liquid has acquired a deep green color. We then recover the acetic acid not consumed in the reaction by distillation, and treat the residuum with water to remove the chromic acetate. From the insoluble mass we obtain the anthraki-

non in a pure state by distilling the whole from a retort of glass or iron.

In the place of acetic acid, sulphuric acid, diluted with one or two parts of water, may be employed.

Instead of the method just described, we also employ the following one: We heat anthracene in a vessel of glass or of clay, with ten parts of concentrated acetic acid, to about 100° centigrade, or a little higher, and we add nitric acid of about 1.3 specific gravity, in small portions till the violent reaction ceases. After distillation of the acetic acid we purify the residuum, as before. We then convert the anthrakinon, prepared by one of the methods described, into bichromanthrakinon. For this purpose we take three parts of anthrakinon, five parts of bromine, and we heat these substances for ten or twelve hours, or until nearly the whole of the bromine has disappeared, to a temperature, by preference, of about 100° 140 centigrade, in a suitable close vessel, either of glass or enameled or glazed iron, which is capable of sustaining the pressure which is generated by the reaction. The apparatus is then allowed to cool. It is opened in order to permit the escape of bromic acid, which can be recovered by absorption either in water or in alkaline solution.

We purify the bibromanthrakinon remaining in the vessel, as a solid substance, by crystallization from benzole.

Instead of the method above described for preparing bibromanthrakinon, we also employ the following: We convert, first, the anthracene into a bromine derivative, into the tetrabromanthracene, known to chemists by the investigations of Anderson; we take one part of this tetrabromanthracene and we heat it in a retort of glass or clay with about five parts of nitric acid, of about 1.3 specific gravity, to 100° centigrade, as long as vapors of bromine are evolved; we distill off the greater portion of the nitric acid, wash the residuum with water, and purify it by crystallization from benzole; we thus receive the bibromanthrakinon, as before, in a yellow solid mass; we then convert the bibromanthrakinon into alizarine; for this purpose we take one part of bibromanthrakinon, two to three parts of caustic potash or soda, and so much water as is necessary to dissolve the alkali, and we heat the same in an open vessel of glass, glazed or enamelled iron or silver, to about 180° to 260° centigrade, for one hour, or till the mass has acquired a deep blue color; we then dissolve it in water, and filter the violet solution, from which we precipitate the alizarine by inorganic acid; we collect the yellow flocks of alizarine thus obtained on a filter and wash them with water.

By these methods we receive the alizarene in a form in which it can be employed in the same manner as the different preparations from madder.

In the place of bromine, chlorine, also, may be employed, but not so conveniently, as the reactions above described are more difficult to accomplish with chlorine than with bromine.

What we claim as new, and desire to secure by letters patent, is—

Artificial alizarine produced from anthracene or its derivatives by either of the methods herein described, or by any other method which will produce a like result.

This specification signed by us this 30th day of November, 1870.

CHARLES GRAEBE.
CHARLES LIEBERMANN.

Witnesses as to the signature of Charles Liebermann:

H. KREISMANN.
G. MAUFE.

Witnesses:

OTTO PETZKE.
ROBT. PRENDS.

141 Department of the Interior, United States Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office of an assignment recorded in liber I^{15}, page 260.

In testimony whereof I, W. H. Doolittle, acting commissioner of patents, have caused the seal of the patent office to be hereunto affixed this twenty-second day of March, in the year of our Lord one thousand eight hundred and seventy-seven, and of the Independence of the United States the one hundred and first.

[L. S.] W. H. DOOLITTLE,
Acting Commissioner.

Assignment.

Whereas we, Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia, did obtain letters patent of the United States of America for certain improvements in process of preparing alizarine, which letters patent bear date the fifth day of October, eighteen hundred and sixty-nine, and are numbered 95,465, which letters patent were surrendered, and new letters patent were obtained by us for the same invention in two divisions, dated April 4, 1871, and numbered 4320 and 4321 respectively;

And whereas Badische Anilin and Soda Fabrik, in Ludwigshafen, a corporation organized under the laws of the Grand Duchy of Baden, German Empire, is desirous of acquiring an interest therein—

Now, this indenture witnesseth, that for and in consideration of the sum of five dollars to us, the said Charles Graebe and Charles Liebermann, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold, and set over, and do hereby assign, sell, and set over, unto the said Badische Anilin and Soda Fabrik, in Ludwigshafen, its successors and assigns, all the right, title, and interest we have in the said invention, as secured to us by said reissued letters patent.

The same to be held and enjoyed by the said Badische Anilin and Soda Fabrik, in Ludwigshafen, for its own use and behoof, and for the use and behoof of its legal representatives, to the full end of the term for which said letters patent are granted, as fully
142 and entirely as the same would have been held and enjoyed by us if this assignment and sale had not been made.

In testimony whereof, we hereunto set our hands and affix our seals, this first day of March, eighteen hundred and seventy-two.

CHARLES GRAEBE. [SEAL.]
CHARLES LIEBERMANN. [SEAL.]

Sealed and delivered in presence of—
DR. C. A. KNOYE.
MERLIN MITTELSTR, 42.

[U. S. Rev. Stamp, 5 cents, cancelled March 1st, 1872.]

Recorded March 28, 1872. Exd. F. F. C. C. W.

Circuit Court of the United States, district of Massachusetts, October term, 1877, to wit, Feb. 4, 1878.

BADISCHE ANILIN AND SODA FABRIK, complainants,
HAMILTON MANUFACTURING COMPANY, defendants. } In equity.

Decree for perpetual injunction, and for reference to a master.

This cause came on to be heard at the May term, A. D. 1877, of this court, upon the pleadings and proofs, and was argued by counsel for the respective parties; and thence this cause was continued under advisement to this present term, and now upon consideration thereof, to wit, Feb. 4, 1878, it is ordered, adjudged and decreed as follows, viz., that the letters patent referred to in complainants' bill, being letters patent of the United States granted unto Charles Graebe and Charles Liebermann for a new and useful improvement in dyes or coloring matter from anthracene, being reissue No. 4,321, dated April 4th, 1871, is a good and valid patent; and that the said
143 Charles Graebe and Charles Liebermann were the original and first inventors of the improvement described and claimed therein; and that the said defendants have infringed the said patent, and upon the exclusive rights of the complainants under the same, who are the sole and exclusive owners of said reissued patent No. 4,321, and of the invention secured thereby.

And it is further ordered, adjudged and decreed that the complainants recover of the defendants the profits which they have received or made, or which have accrued to them from said infringement by the manufacture, use or sale of the improvement described, and secured by said letters patent, at any and all times since the first

day of March, 1872, and also the damages which the complainants have sustained thereby.

And it is further ordered, adjudged and decreed that it be referred to John G. Stetson, esq., a master of this court, to take and report to the court an account of the profits which the said defendants have received, or which have arisen or accrued to them from the manufacture, use or sale of said improvement, or from said infringement, and to ascertain and report the damages which the complainants have sustained thereby since the first day of March, A. D. 1872.

And it is further ordered, adjudged and decreed that a perpetual injunction be issued against the defendants, according to the prayer of the bill.

And it is further ordered, adjudged and decreed that the complainants recover of the defendants their costs of suit.

By the court— JOHN G. STETSON, *Clerk.*

A true copy.

[L. S.] Attest: JOHN G. STETSON, *Clerk.*

144 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK *vs.* HAMILTON MANUFACTURING COMPANY. } In equity.

No. 811.] *Opinion of the Court.*—February 4, 1878.

SHEPLEY, J.—An objection is raised to the validity of the reissued letters patent under which complainants claim that the original patent was taken out in England by Graebe and Liebermann on the 16th of June, 1869, and was suffered to expire, by reason of the omission to pay the annual fees upon it, on the 18th of December, 1871, after the reissue of the American patent for the same invention, dated April 4, 1871. It is contended that the patent in controversy was issued under the act of July 8th, 1870, and that as the 25th section of that act provided that an American patent "shall expire at the same time with the foreign patent" which has been obtained previous to the American patent, the reissue of the American patent expired on the 18th of December, 1871, when the English patent expired.

The act of March 3, 1839, provided, that, in all cases where a patent shall be granted after the same invention shall have been patented in a foreign country, "such patent shall be limited to the term of fourteen years from the date of publication of such foreign letters patent." The act of March 2, 1861, provides "that all patents hereafter granted shall remain in force for the term of seventeen years from the date of issue," and repeals all acts and parts of acts before passed inconsistent with the provisions of the act of 1861. The act of 1870, § 25, provides that in case of a prior foreign patent the United States patent "shall expire at the same time with the foreign

patent, or if there be more than one, at the same time with the one having the shortest term."

The law of July 8, 1870, Rev. Stat., § 4887, was not retroactive, and did not operate to put an end to American patents granted before the law took effect. The original patent in this case was
145 dated October 5th, 1869, before the passage of the act of 1870. Without a breach of good faith to the patentee, who had complied with the provisions of previous acts by disclosing his invention and paying the required fees, Congress could not take away any portion of the term of the patent, or any right to an extension which existed under the laws in force when the patent was granted, and which formed a part of the contract between the parties. Nor is any such intention to be gathered from the words of the statute. The act of 1870 has not, in the practice of the patent office, been acted upon as retroactive. *Apperly* vs. *Clissold*, Com. Dec., 1870, p. 164. This long-continued usage and practice of one of the departments of the government is entitled to be considered by courts with great respect. The act of 1870, while repealing prior acts, contains a proviso saving all rights existing and all remedies which have arisen under any of said laws, and section 5597 of the Revised Statutes contains a similar provision. The patent of Graebe and Liebermann, assigned to the complainants, did not therefore expire when the English patent became void by the omission to pay the annual fees.

The subject of the patent is a new and useful composition of matter, being an improvement in dyes or coloring matter produced from anthracene, and styled in the reissue as "artificial alizarine." Before the invention of Graebe and Liebermann the word alizarine—a word coined from the Arabic and modern Greek names for madder—was commercially applied to a class embracing different varieties of dye-stuffs obtained from the madder plant. These dye-stuffs owed their value not only to a crystallized compound, which can be obtained from the madder and some other plants, known as alizarine, but also to other materials existing naturally in the madder, or produced by the action of fermentation, heat, and the like, and by the aid of chemicals. The term alizarine was also applied by chemists to a theoretically pure crystallized extract from madder, whose formula was C^{14} H^{8} O^{4}. These madder extracts were among the most valuable dye-stuffs known to the world, and to supply the great and constantly-increasing demand for them, large tracts of land were devoted to the raising of madder.

In 1868 Graebe and Liebermann, by a new process invented by them, produced their new composition of matter, now, for want of a name more accurately descriptive, called artificial alizarine, a product unknown to both science and the arts at the date of their invention. Coal tar, (a substance containing a large number of the compounds caused by the various reactions which take place when coal is subjected in close vessels to intense heat,) when submitted to a second distillation, yields at a very high temperature, as one of its products, anthracene, which, when purified, is a white waxy

substance. From this body, named anthracene, Graebe and Liebermann, by the series of chemical treatments described in
146 the specifications, built up a beautiful and complex product, an artificial dyestuff now known as artificial alizarine. This was not a chemically pure alizarine. Their process stopped far short of the elimination from the product of the bodies other than chemically pure alizarine. In fact, the presence of some of the other bodies appears to much enhance the value of the dyestuff produced by their process. This product was one entirely new. The process by which they produced it was entirely new. Anthrapurpurine, isopurpurine and other bodies, combined with alizarine in their product, are not known to have existed before they were produced by Graebe and Liebermann.

This composition of matter, which to a great degree has taken the place of madder preparations in the arts of dyeing and calico printing, was new as to its origin. It was a purely artificial production, built up, as well described by Professors Morton, Hedrick and Ordway, by a process of chemical synthesis from materials, none of which contained it or anything approaching to it, in character or properties Its composition was new; it contained, combined with alizarine, other bodies of themselves effective dyeing agents before unknown, and existing for the first time when produced by Graebe and Liebermann. It was new not only in some of its new chemical properties, but in its capacity to produce in dyeing and calico printing tints which cannot be obtained with the preparations of madder or any other dyestuffs previously known.

Objection is made to the validity of the reissued patent upon which this bill is brought. Graebe and Liebermann, on the fifth of October, 1869, obtained letters patent of the United States, No. 95,465, in which, after describing their process in the words contained in the reissue, they made the following claim: "The within *described process* for the production of alizarine by first preparing bibromanthrakinon or bicloranthrakinon, and then converting these substances into alizarine, substantially as above set forth." This patent was subsequently reissued in two divisions, one for the process and one for the product. In division B, upon which this suit is brought, the claim "artificial alizarine produced from anthracene or its derivatives, by either of the methods herein described, or by any other method which will produce a like result." The right to reissue in two divisions, one for the new process and one for the new product is fully sustained by the opinion of Mr. Justice Clifford, in Goodyear *v.* Providence Rubber Co., 2 Fisher, 510. "No doubt can be entertained that a new product or manufacture, and a new process or method of producing the new article, are the proper subjects of separate and distinct claims in an original patent; and if so, then it is equally clear that the patentee, under that provision, upon a return of the patent for correction and reissue and upon complying with the conditions therein specified, may have several patents for the distinct and separate parts of his invention."

147 When a thing is produced—new—in and of itself, it is patentable as a new manufacture. If it be capable of being produced by various different processes, yet when the product is new independent of the process, the patent is infringed by the unlicensed manufacture of the new product by any made of manufacture, the process of manufacture being wholly unimportant. Merrill *v.* Yeomans, 1 Holmes, 331; Goodyear *v.* R. R., 1 Fisher, 632. But defendants further contend that alizarine was a well known substance long before the patent, and it could not be made the subject of any letters patent, and that the reissue is void as claiming alizarine broadly and as claiming more than the invention described in the original. An examination of the original and the reissue will show that the same process and the same product is described in both. Before the invention, the name alizarine had been used as a generic term, applied to many different dyestuffs, and yellow and green alizarines were in the market. Chemically pure alizarine existed only in the books, and a body approximating to it only in the laboratory of the chemist. As the new manufacture was intended to take the place of the dyestuffs extracted from madder, and as, in common with those dyestuffs, it owed a large proportion of its value as a dye to the presence of alizarine, it was not erroneous, although not accurately descriptive, to apply to this product of a distillation of coal treated with chemicals a name which had been applied to preparations from madder, without any more accuracy in one case than the other. Whatever Graebe and Lieberman called their product in the original or the reissue, it was a new product and they showed what it was and how it could be produced. Pure alizarine, if it ever existed except in chemical notation or laboratory experiment, could not have been made the subject of a patent. Nor have Graebe and Liebermann undertaken to patent alizarine, if by alizarine is meant what was known before their inventions to chemists as the body existing in dyestuffs prepared from the madder. What they have patented is the new composition of matter and the new manufacture, having the described properties, produced from anthracene by any process which will produce their new product.

Before the discovery of the aniline dyes Dahme and Unverdorven, by treating indigo, obtained a new substance which was called aniline, from *anil*, the word used in some countries for indigo, as *al-nil* is the Arabic for the indigo plant. When a similar substance was obtained from coal tar it was also called called aniline. But calling the dye thus obtained from coal tar by the same name as the dye extracted from the indigo plant did not make the aniline dyes and the indigo dyes identical, although they are in some respects identical in composition. So when Graebe and Liebermann's new dye was discovered, they at first called it alizarine, from the Arabic *al-zari*, name of the madder plant. But calling their extract from
148 anthracene by the same name which had been applied to the extracts from madder, did not necessarily imply that the two

things were identical, as most surely they are not in fact, and are shown not to be by the specifications.

Reissue division B must therefore be considered as a valid patent for a new manufacture and composition of matter, and as the evidence clearly proves an unlicensed use by the defendants, there must be a decree for injunction and account, according to the prayer of the bill.

UNITED STATES OF AMERICA, *District of Massachusetts,* } *ss.*

I, John G. Stetson, clerk of the Circuit Court of the United States for the district of Massachusetts, in the first circuit, certify that the foregoing printed pages, 1 to 7 inclusive, are a true copy of the opinion of the court, delivered Feb. 4, 1878, in the cause in equity then and now pending in said Circuit Court, numbered 811 on the docket of said court, and entitled Badische Anilin and Soda Fabrik *vs.* Hamilton Manufacturing Company.

Witness my hand and the seal of the said Circuit Court at Boston, in said district, this fourteenth day of February, A. D. 1878.

[L. S.] JOHN G. STETSON, *Clerk.*

149 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK *vs.* THOMAS K. CUMMINS. } In equity.

CITY, COUNTY AND STATE OF NEW YORK, *Southern district of New York,* } *ss.*

Henry Morton, being duly sworn, deposes and says that he resides at Hoboken, New Jersey, and is president of Stevens Institute of Technology, of that place; that he has occupied the chair of chemistry and physics at the University of Pennsylvania, at Philadelphia, and has for many years given special attention to the subject of chemistry and physics, and has made many researches in those subjects, the results of which have been published in the scientific journals of this country and of Europe; that he has often testified as an expert in patent causes in the United States courts, where patents in controversy related to such subjects.

Deponent further says that he has read and examined letters patent of the United States reissue No. 4321, bearing date April 4th, 1871, granted to Charles Graebe and Charles Liebermann for an improvement in dyes or coloring matter from anthracene, and he believes he understands the invention described therein and specified in the claim thereof; that he has manufactured the article described in said patent and specified in the claim thereof as "artificial alizarine," and mentioned in said specification also as "yellow flocks," a great number of times, probably fifty times, by following the directions and using the means described and set forth in said

patent, and that, in his opinon, any person skilled in the art or science to which said patented improvement relates would be enabled, by following the description contained in said patent, to make and use the product described in the same, and which is specified in the claim thereof; that he has carefully examined and studied said product for the purpose of determining the question of novelty, and that he considers the same to be new in a variety of particulars, among which are the following:

150 In the first place, as a dye stuff, it possesses new properties, being capable of producing, under identical conditions, effects differing from and superior to those obtained from madder and its preparations, for which it is and was intended to be a substitute, as stated in the patent. As a dye-stuff it, moreover, admits of being applied to use in new ways, and yields colors which are more fast, or resist better the actions which tend to fade or destroy the color in dyed fabrics, than does madder root or its preparations. As a chemical substance it is new in its composition, containing, among other things, anthrapurpurine and isopurpurine, substances which do not exist in madder root or its preparations, and which are, moreover, important in their influence on the product as a dye-stuff. This product is, moreover, new in its method of production; it is developed from an otherwise worthless-waste product by a series of steps of chemical construction, in which no forces are involved but those of the chemical affinity between such substances as the ordinary acids, alkalies, and salts.

While, therefore, it is a fit substitute for madder and its preparations, because with it dyers and calico printers can accomplish essentially all the valuable results obtained from madder and its preparations as dye-stuffs, they can by its agency accomplish those results better and to some extent by new instrumentalities.

Deponent further says that for the last ten or more years he has known Mr. James Hunter, of Philadelphia, who has there a very large calico print works, and who was one of the first to use the said patented product—artificial alizarine—in this country, and that he frequently conversed with Mr. Hunter on the subject, and that deponent has visited Mr. Hunter's works and other similar establishments, and has conversed with others engaged in calico printing, and has also read the literature pertaining to the subject, and has also in his own laboratory made numberless experiments with said product and other dye-stuffs for his own information, and has been accustomed to exhibit to his classes in his lectures many experiments illustrating the action of various dye-stuffs and the method of their use.

Deponent further says that the invention specified in said patent has had the effect, by its introduction into use in this country, of largely modifying the processes used in the industries of dying and calico printing, and has caused the process known as topical printing to be largely introduced in the industry of calico printing, the artificial alizarine and the mordant being mixed together and printed

upon the cloth. The introduction of this invention in England, as appears from published statistics, has reduced the importations of madder there to a small fraction of what they were previous to its introduction. In an address of William Henry Perkin, pub-
151 lished in the journal "Nature," September 14th, 1876, page 434, it is stated in substance that the money value of the importations of madder and garancene had been about £1,000,000 per annum during the ten years immediately preceding the introduction of artificial alizarine into the United Kingdom, and that the estimated quantity imported for the year 1876 was only £138,105.

Deponent further says that the introduction of artificial alizarine into the United States has caused several dealers in New York city who formerly imported madder extracts to discontinue such importations, as he ascertained by personally trying to buy some green alizarine, which is a preparation of madder, and which, although at one time largely bought and sold in New York city, could not be found by him in the hands of dealers who had before dealt in it.

Deponent further says that he saw at the works of Mr. Hunter at Philadelphia, in 1876, many tons of madder stored away as practically valueless, and Mr. Hunter gave him to understand that he had in effect abandoned the manufacture of madder extract in which he had before done considerable business, and that this result was caused by the introduction into use of said patented product—artificial alizarine.

Deponent further says that the literature of the subject is full of references showing the immense effect which the said invention of artificial alizarine, and its introduction into use in dyeing and calico printing, has had upon that industry, to improve the goods printed thereby, and to decrease the use and consequently the production of madder.

Deponent further says that he has examined a portion of the contents of the bottle marked Complainants' Exhibit C, March 20th, 1877, R. E. S., examiner, for the purpose of ascertaining what the same is, and that he finds it to be a specimen of artificial alizarine, corresponding in all respects with the product described in the said patent No. 4321 as alizarine or artificial alizarine, and that the following are some of the tests which he used in making such examination, namely:

That he took a portion of the contents of said bottle and dyed with it, in the usual manner, a piece of mordanted cloth, such as is usually employed in such tests, and that the action in the dye-bath, the colors produced, and their change upon soaping corresponded in all respects with the behavior under similar circumstances of the product produced by deponent by following the directions set forth in the said patent.

That he dried and heated a small portion of the contents of said bottle, Exhibit C, and obtained therefrom, by sublimation,
152 crystals which corresponded with those deponent had similarly obtained from artificial alizarine made by him according to the patent.

The deponent took a portion of the contents of said bottle Exhibit C, and treated it with an excess of caustic soda solution, then filtered and washed the undissolved material remaining on the filter, and dried and sublimed the same, obtaining therefrom long yellowish needles of anthrachinone, which substance was mentioned in the beginning of the specification of said patent. To the soluble part or filtrate, deponent added a solution of chloride of calcium in excess so as to precipitate the coloring matter as a lime or calcium lake, and then boiled the whole mass and threw it upon a filter, whereupon there ran through a yellowish red solution. He repeated the boiling with fresh water and again filtered and precipitated both the solutions or filtrates with hydrochloric acid. The precipitates yielded a yellow brown material which was washed on a filter with pure water, dried and sublimed, and it yielded golden yellow flakes of monoxanthrachinone; the insoluble portion or lime lake on the filter was then removed and decomposed with hydrochloric acid and washed to remove all the lime; it was then dissolved afresh in a solution of caustic soda, and precipitated as a baryta lake by a solution of hydrate of baryta. This baryta lake was then boiled and thrown on a filter, whereupon there ran through the filter a reddish liquid, which being in its turn precipitated with hydrochloric acid, yielded yellowish flocks of isopurpurine, which were washed on a filter and then tested by a solution in caustic soda and in ammonia. In caustic soda they produced a solution of a characteristic reddish-purple, and in ammonia a solution of an equally characteristic red.

And that he also tested the contents of said bottle, Exhibit C, by following the methods described by Perkin in the Journal of the Chemical Society, vol. 26, p. 425, and found anthrapurpurine therein.

These tests show among other things that the substance found in said bottle, Exhibit C, contains four bodies which are characteristic of the patented product, artificial alizarine, namely:

Anthrachinone, monoxanthrachinone, anthrapurpurine and isopurpurine; the first of which, anthrachinone, is the body used in the first step of the process described in the patent, and the second, third and fourth are products characteristic of the second step. Neither of these four bodies is found in madder root or its preparations.

Deponent further says that the contents of said bottle, Exhibit C, possess the essential characteristics of the patented product described in said patent, No. 4,321, and that he finds the same to be the product described in said patent and designated therein as artificial alizarine.

153 Deponent further says that he obtained said bottle, Exhibit C, with the contents thereof, from Adolph Kuttroff, one of the firm of Wm. Pickhardt & Kuttroff, of No. 98 Liberty street, New York city, on the 13th day of October, 1876, and had the same in his (deponent's) possession from that day till he produced the same on the 20th day of March, 1877, before Examiner R. E. Stillwell, esq., as an exhibit in the above entitled suit, in giving testimony therein

for final hearing, deponent having taken out some of the contents of said bottle to examine and test the same for the purpose of ascertaining what the same was.

HENRY MORTON.

Subscribed and sworn to before me this sixth day of March, A. D. 1878.

R. E. STILLWELL,
U. S. Com'r for southern district of New York.

154 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK *vs.* THOMAS K. CUMMINS. } In equity.

CITY, COUNTY AND STATE OF NEW YORK, *Southern district of New York,* } *ss.*

ADOLF KUTTROFF, being duly sworn, deposes and says that he is a member of the firm of Wm. Pickhardt and Kuttroff, dealers in dye-stuff and other articles, of 98 Liberty street, New York city, and that said firm are the sole agents of complainants in the United States for the sale therein of artificial alizarine manufactured by said complainant, said artificial alizarine being the article or product described and claimed in the letters patent of the United States reissue No. 4,321, granted to Charles Graebe and Charles Liebermann, April 4th. 1871; that this suit was begun by filing a bill of complaint on the 23d day of September, 1876, a copy whereof is hereto annexed; that the defendant filed his answer thereto, and that complainants filed their replication on or about the 3d day of January, 1877; that complainants have nearly completed the taking of testimony for their prima facie case in said suit; that deponent has read the affidavit of Prof. Henry Morton hereto annexed, and that the contents of the bottle, Complainants' Exhibit C, referred to in said affidavit, are a part of the contents of a barrel of artificial alizarine bearing the mark "CII," which deponent saw at the works of the Oriental Print Works, at Apponaug, Rhode Island, on the 10th day of February, 1876, and that the contents of said Exhibit C were taken out of said barrel, and obtained by deponent on that day at said works, in the presence and by the permission of John D'Arcy, the superintendent of said works, who informed deponent that said barrel, and another barrel of artificial alizarine bearing the mark CIV, which was also then and there present, had been lately bought by said print works from the above-named defendant; that deponent, upon receiving the portion so taken from said barrel CII, placed the same in said bottle Exhibit C; that the label, partly printed and partly written,
155 which is on said Exhibit C, was placed thereon by deponent, and that the words and figures thereon, to wit, "Alizarine, Artf., CII., obtained at Oriental Print Works, Feb. 10, '76," are in

deponent's handwriting; that deponent also filled another bottle at the same time and place from the contents of said barrel CIV, and that he kept both said bottles and their contents in his possession from said Feb. 10th, 1876, until October 13th, 1876, on which day he handed them to Prof. Morton, to have their contents tested by said Morton.

Deponent further says that the artificial alizarine described and claimed in said patent is intended as a substitute for madder and its preparations in dyeing and calico printing, and that deponent's firm have, as the agents of the complainants, aided in introducing the same into use in the United States; that they had at first great difficulty in inducing dyers and calico printers in this country to use the same in the place of madder and its preparations, as they were reluctant to believe that a good substitute for those old dye-stuffs had been created, and many of them ridiculed the idea that the new dye-stuff, artificial alizarine, could be equal to madder, which latter had been always considered the type of fast colors, and it was only after continued and great efforts on the part of complainants and deponent's firm that dyers and calico printers were induced to try the said artificial alizarine, but after they had tried the same they immediately began to use it, and its use in those industries has now become general and very large in this country; that the chief consumers of artificial alizarine are calico printers, numbering in this country not much over thirty establishments.

Deponent further says that the complainants are fully able and willing to supply the demand in the United States for said artificial alizarine, and have made ample preparations to manufacture the same in sufficient quantities to supply such demand, and have through deponent's firm sold and offered to sell the same at reasonable prices, and at lower prices, reckoning the amount of cloth printed, than were formerly paid by consumers for dye-stuffs made from the madder root, and that madder dye-stuffs have been to a large extent driven out of the market in this country, by reason of and since the introduction therein of the said artificial alizarine by complainants and their said agents, and that complainants through their said agents still continue to sell and offer the same for sale at their own places of business in New York, Boston, Providence and Philadelphia, which cities are contiguous to the principal print works in this country.

Deponent further says that the defendant was formerly a large importer into the United States of madder and its preparations, and that he did all in his power to prevent the introduction and use in this country of said artificial alizarine as a dye-stuff, but after the same had been successfully introduced by the complainants and their said agents, the said defendant, finding, as deponent believes,
156 that his sales of madder dye-stuffs were rapidly decreasing, commenced to import from Europe said artificial alizarine, and that he has from about the beginning of the year 1876 been very active in importing and selling the same in this country, telling

consumers that he would always sell said artificial alizarine at prices cheaper than the prices charged by deponent's firm therefor, no matter what prices deponent's firm charged therefor, and offering consumers to guarantee them against all liability to complainants on account of said patent of Graebe and Liebermann.

Deponent further says that the advantages derived by consumers of artificial alizarine in dyeing and calico printing over the best results which could be obtained by them from the use of madder dyestuffs were such that the consumers in this country were satisfied with the prices charged therefor by deponent's firm, and that they also were satisfied with the quality of the article furnished by deponent's firm, but that many have been induced by the continual underselling by defendant, and by his guarantees or offers of guarantees against the consequences of infringement of complainants' patent, to buy said artificial alizarine from the defendant; and deponent further says that he is informed and believes it to be true that said defendant does business under the name or style of Thomas K. Cummins & Co., and has a place of business at Boston, Massachusetts, and that he is a commission merchant, and only sells said artificial alizarine as a commission merchant, and that he is not considered in business circles at the place or places where he does business as possessed of any considerable amount of capital, and that he has very little or no capital invested in business in this country, and deponent, therefore, apprehends that complainants will not be able, if they awarded damages in this suit, to recover the same by the ordinary process of execution after final decree.

And deponent further says that the defendant and other infringers have, by their sales of said patented product, inflicted great loss upon complainants, and deprived them of great gains and profits which they would otherwise naturally have made by sales in this country of said artificial alizarine under said patent, but which sales they have been prevented, and are now prevented from making by reason of the said sales thereof by the defendant and others.

Deponent further says that the complainants in September, 1876, brought suit in this same court and district in equity, against Hamilton Manufacturing Company, for infringing said reissued letters patent, No. 4321, praying in their bill of complaint, in said suit, for an injunction, and an account of profits and for damages, and the said company appeared therein by Messrs. Dickerson and Beaman,
of New York, their solicitors, and put in their answer, and
157 that issue was joined in said suit, and that testimony was taken
therein, and that said suit was brought to final hearing before this honorable court, before his honor, Geo. F. Shepley, circuit judge, and that the said judge on the 4th day of February, 1878, rendered his decision in said suit, adjudging said patent, reissue No. 4321, to be a valid patent, and ordering a decree for an injunction and account as prayed for in said bill, and that by the order of said court an interlocutory decree was entered in said suit against said Hamilton Manufacturing Company, February 4th, 1878, and that the paper hereto annexed

marked "Exhibit Opinion" is a copy of the opinion delivered by the court on deciding said suit.

Deponent further says that the complainants are a corporation organized under the laws of the Grand Duchy of Baden, in the Empire of Germany, and that the annexed certificates, marked as follows: "Copy of Complainants' Exhibit, Translation No. 1, February 26th, 1878, R. E. S., exm'r," and "Copy Complainants' Exhibit, Translation No. 2, February 26th, 1878, R. E. S., exam'r," are true copies of exhibits put in evidence before R. E. Stillwell, esq., examiner, on said February 26th, 1878, in the taking of the deposition of deponent on that day for final hearing in the above entitled suit, and that the same are correct and true translations of original certificates in the German language, put in evidence as exhibits in said suit at the same time and place.

ADOLF KUTTROFF.

Subscribed and sworn to before me this sixth day of March, A. D. 1878.

R. E. STILWELL,
U. S. Com'r for southern district of New York.

158 *Complainants' Exhibit, Translation No.* 1.—R. E. S., exam'r, February 26th, 1878.

Certificate.

On request of the "Badische Anilin and Soda Fabrik," of Manheim, it is hereby certified:

1. That section 213 of the "Allegemeines Deutsches Handelsgesetzbuch," (code of general German commercial law,) which is and has been in force since the 1st of January, 1863, in the Grand Duchy of Baden, reads as follows:

"The stock company as such has its independent rights and duties; it can become possessed of property and of rights and real estate; it can sue and be sued in courts; its legal domicile is at that court in whose district it has its seat."

2. That in pursuance of this law, no special grants of corporate rights can be made in the Grand Duchy of Baden to stock companies, but the exercise of those rights which appertain to stock companies in accordance with section 213 of the "Allgemeine Deutsche-Gesetzbuch," by virtue of the law depends solely upon the registering of the stock company in the commercial register.

3. That the entry in the commercial register only takes place when the accomplishment of the legal conditions necessary to create a stock company have been shown to the grand ducal district court which is entrusted with the keeping of the commercial register.

4. That according to the laws of the Grand Duchy of Baden, when such stock company shows by an extract from the commercial register that it is duly registered as a stock company, it is entitled to the

protection and recognition of the courts, and has the right of
159 appearing as complainant and defendant, and has the same rights as a society endowed with corporate rights.

Carlsruhe, December 4th, 1877, grand ducal ministerium of the house of the Grand Duchy and of justice.

[L. S] (Signed) GRIMM.

No. 6158. It is hereby certified that the above execution of the judicial and grand ducal ministerium and the signature of the president of the same, Dr. Grimm, is true.

Carlsruhe, December 11th, 1877, state ministerium of the Grand Duchy.

[L. S.] (Signed) TURBAN.

UNITED STATES CONSULATE } ss.
at Manheim, }

I, Edward M. Smith, consul of the United States of America at Manheim, Germany, do hereby certify that Mr. Turban, whose name is subscribed to the paper hereunto annexed, was at the time of subscribing the same minister of state at Carlsruhe, Baden, Germany, duly commissioned to execute such acts, and that his signature thereto is genuine.

In testimony whereof I have hereunto subscribed my name and affixed the notary seal of the said consulate at Manheim, the 11th day of January, A. D. one thousand eight hundred and seventy-eight.

[L. S.] (Signed) EDWARD M. SMITH,
No. 14, rec'd. *Consul of the United States.*

160 *Complainants' Exhibit, Translation No.* 2.—R. E. S., exam'r, February 26th, 1878.

Certificate.

The undersigned, the Grand Ducal District Court, endowed with the supervision of the commercial register for the judicial district of Manheim, hereby certifies that the "Badische Anilin and Soda Fabrik," at Manheim, by reason of the documents presented to this court, and which documents are filed in this court, by which organization according to law has been established, has been entered in the commercial register, under the date of the 15th of June, 1865, as a stock company, and that it still exists as such to this day.

Manheim, 18th of December, 1877. Grand Ducal District Court.

[L. S.] (Signed) MUXUG.

No. 12,602. The above signature and seal of the Grand Ducal District Court, Manheim, is hereby certified to be true.

Carlsruhe, December 27th, 1877, ministerium of the Grand Ducal Court and of justice.

[L. S.] V. SEYFREUNG.

No. 16. The signature of the above execution of the grand ducal and judicial ministerium is hereby certified to be true.

Carlsruhe, January 2d, 1878, state ministerium of the grand duchy of Baden.

[L. S.] (Signed) TURBAN.

UNITED STATES CONSULATE AT MANHEIM, *ss.*

I, Edward M. Smith, consul of the United States of America at Manheim, do hereby certify that Mr. Turban, whose name is subscribed to the paper hereunto annexed, was, at the time of subscribing the same, minister of state at Carlsruhe, Baden, Germany, duly commissioned to execute such acts, and that his signature thereto is genuine.

In testimony whereof, I have hereunto subscribed my name and affixed the seal of the said consulate at Manheim, the 11th day of January, A. D. one thousand eight hundred and seventy-eight.

[L. S.] (Signed) EDWARD M. SMITH,
No. 15 rec'd. *Consul of the United States.*

161 *Complainants' Exhibit D'Arcy Deposition.*—March 1st, 1878, R. E. S., examiner.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

BOSTON, February 4, 1876.

ORIENTAL PRINT W'KS

Bought of T. K. CUMMINS & Co.,
76 Devonshire st., Boston.
61 William st., New York.

Two (2) barrels alizarine.
Weighing as per return. Currency, gold.

		gr.	T.	Nett.
No. 5263.	4C	334	41	293
No. 5275.	2C	320	44	276

569 lbs. nett c 60 c. Gold per pd $341 40
Drayage 50
Rec'd p'ym't M'ch 11, 1876.
T. K. CUMMINS & CO.
Per C. F. HOWE.

162 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

APPONAUG, COUNTY OF KENT,
State and district of Rhode Island, } *ss.*

JOHN D'ARCY, being duly sworn, deposes and says that he resides

at Apponaug, Rhode Island, and is superintendent of the Oriental Print Works at that place; that said Oriental Print Works at different times in the years 1876 and 1877 purchased from the above-named defendant Thomas K. Cummins dye-stuff or coloring matter known as artificial alizarine, and that the said defendant sold to said Oriental Print Works two barrels of artificial alizarine on the 4th day of February, 1876, which were received from the said defendant at said works between that day and the 10th day of February, 1876, and that the bill of sale hereto annexed, marked Complainants' Exhibit Cummins Bill of Sale, is the bill of sale from said defendant of said lot of artificial alizarine, and that on or about the 10th day of February, 1876, this deponent, at the request of Adolph Kuttroff, of the firm of William Pickhardt & Kuttroff, of New York city, gave to said Kuttroff some of the said artificial alizarine mentioned in said bill of sale, and which had been received by said Oriental Print Works from the said defendant as aforesaid.

JOHN D'ARCY.

Subscribed and sworn to before me this 18th day of February, 1878. Attest my hand and seal notarial the day and year last above written.

[L. S.] SAM. W. CLARKE,
Notary Public.

163 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

SOUTHERN DISTRICT OF NEW YORK, } *ss.*
City and county of New York,

RICHARD E. STILWELL, being duly sworn, deposes and says that he resides in said city of New York, and is an examiner of the United States Circuit Court in and for the southern district of New York, and that the foregoing bill of sale and affidavit of John D'Arcy, marked "Complainants' Exhibit D'Arcy Deposition," are true copies of Complainants' Exhibit D'Arcy Deposition, put in evidence before him March 1st, 1878, by complainants in the suit in which said affidavit is entitled, and that the said affidavit and bill of sale, of which the foregoing are copies, are now in his possession as such examiner.

He further says that the annexed printed copies, entitled "Complainants' Exhibit, Translation No. 1, R. E. S., exam'r, February 26th, 1878," and "Complainants' Exhibit, Translation No. 2, R. E. S., exam'r, February 26th, 1878," are true copies of papers put in evidence as exhibits in said suit before him as such examiner, on the 26th February, 1878, and that said exhibits are now in his possession, and that the bottle marked "Complainants' Exhibit C, March 20th, 1877, R. E. S., examiner," hereto annexed, is an exhibit put in evidence on that day in this suit for final hearing, and was so marked

by deponent, and that deponent, at the request of complainants' solicitor, entruste the same to him to be taken before the court.

R. E. STILWELL.

Subscribed and sworn to before me this sixth day of March, 1878.

[L. S.] CHAS. SEDGWICK,
Notary Public, N. Y. co., N. Y.

164 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
THOMAS K. CUMMINS.

STATE OF NEW YORK, COUNTY OF DUTCHESS, *ss.*

WILLIAM BOGLE, being duly sworn, deposes and says: I am forty-three years of age. I reside at Wappinger's Falls, Dutchess county, state of New York. I am the manager of the Dutchess County Print Works, of which Messrs. Garner & Co. are the agents, situated at New Hamburg, Dutchess county, New York. I have been in that situation for two years. I have been engaged in calico-printing since my boyhood, and believe that I understand the art of calico-printing and the use and value of the various materials used for producing colors in calico-printing. The establishments of which Garner & Co. are agents are the largest in the United States, and are divided into two parts, one of which is at New Hamburg and the other at Haverstraw, on the opposite side of the Hudson river, at each of which places there are twenty printing-machines, having a capacity together of producing more than two hundred miles of printed calico a day. In the course of my business I have used all the varieties of madder preparations, and also the article called artificial alizarine, said to be produced from anthracene, and I
165 know the effects produced by all of these preparations.

Madder is imported from Turkey, from France, and from Holland, and each of these varieties differs from the other in its capacity for dyeing.

Garancene is a preparation of madder made by treating the madder root with sulphuric acid in a greater or less quantity, which destroys a certain portion of the root that naturally contains some scarlet coloring matter. "Alizarine" is another preparation of madder, and has been known in the trade for many years by that name, and it is produced by treating madder with very large quantities of acid. "Madder extract" is still another preparation of madder, in which the fibrous portion of the roots is wanting, and the product is more nearly pure. Each of these three preparations of madder produces a different result. Madder treated with from twelve to twenty-five per cent. of acid makes the best red and chocolate colors; madder treated with two or three times as much acid makes the brightest colors, but they are fugitive.

Different brands of garancene made from French madder differ from each other in the tints which they produce, and in the fastness of the coloring; and, generally speaking, garancene does not leave the white portion of the cloth as pure as madder itself does.

"Alizarine"—that is, madder treated with from one hundred to two hundred per cent. of acid—will not produce good red colors, but does make good purples.

"Madder extract," in my experience, has not given as good or cheap results as either madder root, garancene, or alizarine. When the goods printed with the extract are "soaped," the "soaping" takes out the coloring from the figures, and diffuses it over the white ground.

When the madder roots themselves are used for dyeing the cloth, instead of the different preparations already described, there is found a great difference between the roots produced in different parts of the madder-producing regions.

Turkey madder will not give good pink colors, but will
166 make a faster purple than the French madder, while French madder will make a much better and faster pink than Turkey madder can, but will not give as good a purple tint.

Dutch madder makes the best garancene for general work and for chocolate colors, while French makes the best for pink and the Turkey madder makes the best for purple colors.

In using madder and its preparations the practical printer has to select among the different varieties I have mentioned, according to his experience and knowledge, in order to produce the tints which he desires, and the variety of effects is so great that some madder preparations are utterly useless for producing some colors, while they are the most useful in producing others.

What is called artificial alizarine is used in the same manner and for the same purposes for which the different preparations of madder are used. There is a great variety in artificial alizarines, and the different brands or manufactures differ from each other in effects, just as much as the different varieties of madder do; and in producing any particular tint, it is necessary to select a variety of artificial alizarine in order to produce the tint which was desired. There are no colors and no shades of color that can be obtained by artificial alizarine that cannot be obtained with madder or its preparations; and there is no result in topical printing by artificial alizarene that is not obtainable with preparation of madder, and it is not true that the colors produced by artificial alizarine are more fast than those produced by madder.

The process of calico printing and dyeing consists substantially in two steps: First, there is printed upon the plain cloth the desired pattern in what is called a "mordant," which is a salt of some metal, as, for instance, of iron, alumina, tin, and the like, mingled with starch to make a paste. When printed, the pattern is not conspicuous; but when the cloth is dyed in a solution of madder or its va-

rious preparations or artificial alizarine, the reaction which oc-
167 curs between the mordant and the alazarine in the dye-beck produces the desired color, and that color is always the product of the two elements involved in producing it, which may be varied in strength and proportion indefinitely. What will be the result in any given case must be ascertained experimentally; and the skilled printer knows the proper combinations from his or other experience. If some preparation of madder is used with a certain strength of mordant, the color which is produced will be somewhat different in tint from that which will result from the same elements used in different relative strengths; and therefore it follows that a piece of cloth, printed with a given strength of mordant, will be dyed of a different tint according to the quality of the madder preparation used for the purpose; and under identical conditions two different and distinct results will be produced by using different varieties of madder preparations. The same is true in respect to the use of artificial alizarine under identical conditions; and different solutions of artificial alizarine will produce entirely different shades of color upon two pieces of cloth printed with the same mordant, and it is no proof whatever either that two baths of madder or two baths of artificial alizarine are substantially different from each other, because under identical conditions they will not produce similar effects, or that one of the two will produce superior effects.

In what is called topical printing, the mordant and the madder preparation or the artificial alizarine are mingled together with the paste, and are together printed upon the white goods, and then the cloth is submitted to a bath of steam, when the reaction occurs between the mordant and the alizarine which produces the fast color desired. One of the advantages of this mode of printing is that a greater variety of colors can be imprinted upon the cloth than can be by the dyeing process, because as the dye bath acts upon all the cloth at once the same quality of madder or alizarine preparation must be applied at once to all the imprinted mordants; whereas in topical printing different varieties of madder or artificial alizarine are mingled with the mordants, and the cloth which is thus printed
168 has the advantage of the fact that different varieties of alizarine, or of madder preparations to produce different colors, are all used at once, thereby producing all varieties of colors. Thus, for example, if a dye-bath were prepared with French madder for the production of the best pinks, and it was desired to print upon the cloth along with the pink a purple figure, then the purple color could not be well produced in that bath, whatever mordant might be used; and conversely, if the bath were charged with Turkey madder, it would produce a fine purple, but the pink would be bad. When topical printing is used, however, the Turkey madder can be mingled with the mordant which is to be used to produce the puple figures, and the French madder can be mingled with the mordant which is to be used to produce the pink figures, and each is printed from a different cylinder on to the cloth, and when the cloth is subjected

to steam the reactions occur to the best advantage in both the figures, and thereby the best purple and the best pink are produced at the same time. Nothing can be produced in topical printing by artificial alizarine which cannot be produced by madder preparations of some kind; but in topical printing there is more color wasted than in dyeing, and the cheapness with which the material can be furnished therefore affects the use of that method of printing which has to compete with dyeing in price.

In topical printing it is necessary to use different varieties of artificial alizarine on the same piece of cloth, in order to produce the different colors that are desired, and which can be produced only in topical printing, and in that respect artificial alizarine is exactly like the madder preparations, and does not differ from them in the mode of its use and in the necessity for selecting the different qualities to suit the demands of each particular case.

WILLIAM BOGLE.

169 STATE OF NEW YORK, *County of Dutchess.* } *ss.*

On this twentieth day of April, eighteen hundred and seventy-eight, before me personally appeared William Bogle, to me known to be the person named in above affidavit, and who, on being sworn by me, did swear that the above affidavit is just and true to the best of his knowledge and belief.

[SEAL.] W. HENRY REESE,
Notary Public.

U. S. Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
THOMAS K. CUMMINS.

STATE OF NEW YORK, *County of Dutchess,* } *ss.*

James Threlfall, being duly sworn, deposes and says: I am forty-eight years of age; I reside at Wappinger's Falls, Dutchess co., N. Y.; I am the dyer at the Dutchess Co. print works, of which Messrs. Garner & Co. are the agents at New Hamburg, Dutchess co., N. Y., of which William Bogle is the manager, and I have been in that position for fourteen years; I am entirely familiar with the use of the different preparations of madder and artificial alizarine for the purpose of dying calicoes.

170 I have heard the affidavit of William Bogle in this case read, and I know the statements therein made to be true; and it is my every-day practice in the print works of Garner & Co. to use such madder preparations, or such brands of artificial alizarine as my experience has taught me, when combined with certain mordants, would produce the best results. Every color which I can produce

by the use of artificial alizarine of the different grades I can produce by the use of some one of the different preparations of madder.

There is as much difference in the different colors that can be produced by the different products of artificial alizarine as there is in the different colors that can be produced by the different preparations of madder. A practical dyer learns by experience what preparation of madder or what grade of artificial alizarine will produce particular tints or colors that he desires to produce, and he selects accordingly for the work he has to do.

JAMES THRELFALL.

STATE OF NEW YORK,
County of Dutchess, } *ss.*

On this 20th day of April, 1878, before me, personally appeared James Threlfall, to me known to be the person named in the foregoing affidavit, and who swore that it is just and true, to the best of his knowledge and belief.

[L. S.] W. HENRY REESE,
Notary Public.

171 U. S. Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS. } In equity.

STATE OF NEW YORK,
County of Dutchess, } *ss.*

Samuel W. Johnson, partner of Garner & Co., being duly sworn, deposes and says: I have for many years purchased all drugs and chemicals used by the print works of which Garner & Co. are agents, situated at Haverstraw and Wappinger's Falls; have purchased and used alizarine of several different brands from different dealers; have used large quantities of madder and garancine, and still continue to use garancine in large quantities.

SAMUEL W. JOHNSON.

Subscribed and sworn before me this 20th day of April, 1878.

[L. S.] W. HENRY REESE,
Notary Public, Dutchess co., N. Y.

172 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS & Co.

UNITED STATES OF AMERICA, *ss.*

ALBERT HORTON, of Pawtucket, Rhode Island, being duly sworn, deposes and says:

I am superintendent of the Dunnell Manufacturing Company of Pawtucket, Rhode Island, and manufacturer of printed goods by the use of dyes. I have been for several years familiar with the use of madder and its preparations; also, since its introduction, with the use of what is known as artificial alizarine. There is a great variety in different madder roots and in the different preparations of madder, and also in the different brands of artificial alizarine and their capabilities, varying largely and indefinitely.

The different colors which can be produced depend upon the country in which the madder grows, and the mode of its manufacture when madder is used, and upon different processes in the manufacture of artificial alizarine; and the printer must know experimentally what results can be produced by these varieties before he practically applies them to use. There is no color or shade which can be produced by artificial alizarine which cannot be produced also by madder or its preparations, and there is no degree of fastness of color which can be produced by artificial alizarine superior to madder or its preparations.

The use of artificial alizarine in preference to madder is
173 determined by its price. It is now manufactured and sold so cheaply that it may be used more advantageously in practice than madder preparations, but, notwithstanding this, madder preparations are still used in calico printing.

In topical printing the cheapness of artificial alizarine, as compared with madder extract, makes it desirable for that sort of work.

ALBERT HORTON,
Supt. Dunnell Mfg. Co.

Witness: CHAS. P. ADAMS.

STATE OF RHODE ISLAND, } *ss.*
Providence, }

In Pawtucket, this nineteenth day of April, A. D. 1878, the aforesaid Albert Horton personally appeared before me, and, having been duly sworn, declared the foregoing statement by him made to be true and correct to the best of his knowledge and belief.

[SEAL.] CHAS. P. ADAMS,
Notary Public.

174 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
THOMAS H. CUMMINS. } In Equity.

STATE OF NEW HAMPSHIRE, } *ss.*
County of Strafford, }

JOHN BRACEWELL, being duly sworn, deposes and says: I am forty years of age, and reside in Dover, New Hampshire. Am superin-

tendent of the Cocheco Print Works of said city, and have been so for seventeen years. I am very familiar with the use of madder, garancine, madder alizarine and madder extract, and what is known as artificial alizarine, in the production of printed goods. I have used the artificial alizarine sold by Pickhardt & Kuttroff, such as their "D," "b D," and "R" alizarine. Have used some bought of Messrs. Beach & Co., A. Cochrane & Co., James Higgins and Co., and Messrs. T. K. Cummins & Co., each of these parties having supplied us with several varieties. Madder and its preparations, grown in different localities, such as France, Holland and Turkey, will impart to the same mordant a difference in color according to the country in which the root has grown. Artificial alizarine will vary according to brand the same as the different brands of madder, or its preparations, in the results produced; and the different brands have to be selected for the different results required, whether artificial alizarine or madder and its preparations are used. To show the difference in the different brands of artificial alizarine, I can obtain
175 a scarlet with one brand, and with the same mordant and exactly same circumstances I can obtain a crimson with another brand. The same is true of the different brands of madder and its preparations. The bright red color known as Turkey-red, obtained by the use of an oil mordant, has been known for a great while, and was and is obtained from madder. No colors can be produced by artificial alizarine which cannot also be produced by madder or some preparation of madder. In topical printing, the mordant and the alizarine are applied together to the cloth. This method of printing was known for years before the introduction of artificial alizarine.

Madder alizarine was and is used for topical printing, and artificial alizarine is now also used for the same purpose. It (artificial alizarine) being in a more convenient form, as well as cheaper than madder alizarine, is a great reason for its increased use. But similar results, however, can be obtained from madder alizarine. Colors made from the use of artificial alizarine are no more fast than those obtained by madder, as madder colors are perfectly fast, and nothing can be more permanent than they are.

JOHN BRACEWELL,
Supt. Cocheco Print Works.

APRIL 18, 1878.

THE STATE OF NEW HAMPSHIRE, *Strafford,* } *ss.*

There personally appeared the said John Bracewell, and subscribed and made oath to the foregoing before me.

[SEAL.] SAMUEL M. WHEELER,
Notary Public.

176 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS & Co.

UNITED STATES OF AMERICA, *ss.*

ROBERT HENRY, of Fall River, Massachusetts, being duly sworn, deposes and says: I am the superintendent of the American Print Works, at Fall River. I am familiar with the use of madder and its preparations, and also artificial alizarine, in the business of printing.

The different colors and shades which are produced in dyeing with madder or its preparations, or with artificial alizarine, are subject to great variations according to the mode of manufacture and other circumstances attending the growth of the madder and the production of the manufactured articles; and that which is suitable for one shade or color will not produce advantageously some other shades or colors. The manufacturers of artificial alizarine supply a considerable variety of product, all being produced from anthracene, and being capable of producing the same range of colors with different mordants that madder and its preparations will produce; but there is no color or shade which can be produced by the use of artificial alizarine which cannot also be produced by madder or some of its preparations, and the colors dyed with artificial alizarine are not more fast than those dyed with madder.

The use of artificial alizarine instead of madder or its preparations is determined entirely by its cheapness. For the purpose of topical printing, madder extracts has to be practically prepared, which
177 involves an expense that is not required for the use of the same dyeing principle in the dye-bath, and therefore, in this kind of printing, the cheapness with which artificial alizarine is now made is an important and controlling element.

ROBERT HENRY.

FALL RIVER, *April* 17, A. D. 1878.

STATE OF MASSACHUSETTS,
County of Bristol, } *ss.*

There personally appeared Robert Henry, and made oath that the foregoing affidavit by him made is just and true. Before me.

BENJAMIN EARL,
Notary Public.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

STATE OF MASSACHUSETTS,
County of Middlesex, } *ss.*

HENRY BURROWS, being duly sworn, deposes and says: I am 55 years of age; reside at Lowell.

I am superintendent of the print works of the Merrimack Manufacturing Company of Lowell, and have held that position for twenty-three years.

I am quite accustomed to the use of madder and its preparations, such as garancene, alizarine, and madder extract, as well as
178 what is known as artificial alizarine, in the production of printed goods. I have used artificial alizarine sold by Pickhardt & Kuttroff, also Cochrane & Co., Higgins & Co., etc., as examples.

Madder grown in different localities, say France, Holland, and Turkey, will give a different shade of color when used with the same mordant, as well as will the various preparations, such as garancene, madder alizarine, and madder extract.

Different brands of artificial alizarine produce as different results as do the different brands of madder or its preparations, and the printer is obliged to use different brands to produce the desired colors or shades, whether artificial alizarine or madder and its preparations are used.

For example, I will use a certain brand of artificial alizarine, and I will obtain a bright scarlet; with the same mordant and identical conditions I will obtain from another brand a deep crimson.

The above is true of different brands of madder and its preparations.

The color commonly called Turkey-red has been produced from madder, and is not a new color produced only since the introduction of artificial alizarine. In using any given mordant, it is merely a fact of experiment and experience for the printer or dyer to learn what brands of either artificial alizarine or preparations of madder to use, to obtain a desired result.

In topical printing, the alizarine with the mordant are together applied to the cloth, and for some time before the use of artificial alizarine was this method adopted. Madder alizarine was and is used in topical printing, and since the introduction of artificial alizarine it also is used for topical printing. Artificial alizarine, being in a more convenient form, is used more extensively for that purpose than is madder alizarine.

Its also being cheaper in price is a principal reason for its use in topical printing. But no different results are obtained than can be

by use of madder alizarine. Artificial alizarine colors are no
179 more fast than madder colors. Colors produced from madder are absolutely fast, and no colors can be more permanent than they are.

HENRY BURROWS.

LOWELL, *April* 18, 1878.

COMMONWEALTH OF MASSACHUSETTS, *Middlesex*, } ss.

Before me personally appeared the above-named Henry Burrows, and made oath to the truth of the above statements, and subscribed the same in my presence.

[SEAL.] SAMUEL B. WAYMAN,
Notary Public.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK *vs.* THOMAS K. CUMMINS. } In equity.

STATE OF MASSACHUSETTS, *County of Middlesex*, } ss.

THOMAS WALSH, being duly sworn, deposes and says: I am a resident of Lowell, in the county and state aforesaid; my age is forty-seven; I am superintendent of the print works of the Hamilton Manufacturing Co. of that place, and have been so for two and a half years, and a printer for twenty-eight years. I am very
180 familiar with the use of madder, garancene, madder alizarine, and madder extracts, and what is known as artificial alizarine, in the production of printed goods. I have used the artificial alizarine sold by Pickhardt & Kutroff, as well as that sold by A. Cochrane & Company and Higgins. The brands sold by Pickhardt & Kutroff which I have used are marked R, V, D, R, Y, R, B, D, etc.

The different varieties of madder preparations, such as garancene, madder alizarine, and madder extract, produce differences in the color which they impart to the same mordant, and that difference is seen in the madder root itself when used as a decoction, when the madder has been produced in different regions, such as Turkey, France, and Holland. The different brands of artificial alizarine vary in results they produce in the manner that the different varieties of madder preparations vary, and the dyer has to select the different varieties to produce the various different desired results, the same whether madder preparations or artificial alizarine is used. If red color is to be produced, it may be crimson or scarlet, and one brand of artificial alizarine will produce one of those colors, and another brand another, with the same mordant, and under identical conditions; and the same is true in respect to the madder preparations.

The brilliant red color known as Turkey-red, using an oil mordant, is produced from madder, and has been known for generations.

No colors or shades of colors can be produced by the use of artificial alizarine which cannot also be produced from madder or the above preparations. It is a matter of experiment and experience to ascertain what colors will be produced from the different varieties of madder preparations or artificial alizarine using any given mordant; and this experience has to be acquired in dealing with artificial alizarine just as in dealing with different varieties of madder or its preparations.

In topical printing, the mordant and the alizarine are applied together to the cloth, and this method has been used for some years before the introduction of artificial alizarine. Madder ali-
181 zarine, or, as it was called in the trade, alizarine, being a preparation of madder, was and is used for that purpose, and artificial alizarine is now used also for that purpose. The artificial alizarine is in a very convenient form, and therefore is used for that purpose more than madder preparations. Its cheaper price also induces its use for topical printing, where there is a greater waste of coloring matter than there is in dyeing, but the same result in topical printing can be produced by the use of madder alizarine. Colors produced by the use of artificial alizarine are no more fast than those produced by madder. The colors produced by madder are absolutely fast, and nothing can be more permanent than they are.

(Signed) THOMAS WALSH.

Subscribed and sworn to this 15th day of April, in the year of our Lord 1878, before me, a notary public in and for said county of Middlesex, and resident in Lowell. Witness my hand and official seal.

[SEAL.] (Signed) GEORGE STEVENS,
Notary Public.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK }
vs. }
T. K. CUMMINS & Co. }

UNITED STATES OF AMERICA, }
Eastern district of Pennsylvania, } *ss.*

JAMES HUNTER, of Philadelphia, Pa., being duly sworn deposes and says: I am the same person who was examined as a witness by the complainant in the suit of the Badische
182 Anilin und Soda Fabrik *vs.* Hamilton Manufacturing Company, and the testimony which I then gave for the complainant I now affirm. When I was examined there was no counsel for the defendant present, and I was never cross-examined, and was never asked questions in respect to what I am now about to testify.

I have manufactured large quantities of garancine and madder extracts, and used them in my business, and I have also used large quantities of artificial alizarine, and I believe that I understand the value of all these products. Topical printing was largely carried on before artificial alizarine was introduced in the market, and the extract of madder was used for that purpose. The cost of the extract of madder, however, made the process comparatively expensive, and therefore its use was limited.

Artificial alizarine has been sold, however, cheaper, and by reason of that fact topical printing is more largely practised than it was with madder extract.

There is no effect, however, neither in color nor shade, which can be produced by artificial alizarine which cannot also be produced by some form of madder preparation, and the colors are equally fast whether they are produced by madder preparations or artificial alizarine.

In the use of either or any of these different preparations different shades of color are produced by different varieties, and that is as true with madder preparations as with artificial alizarine, and the manufacturers supply preparations suitable for producing different colors as they are needed.

I did not say I had many tons of madder stored away as practically valueless. What I did say was that the introduction of cheap artificial alizarine made the manufacture of madder extracts unprofitable. Madder is manufactured extensively to-day into garancine to be used for the purpose of dyeing calico.

(Signed) JAMES HUNTER.

Sworn to and subscribed before me the 17th day of April, A. D. 1878.

SAMUEL B. HUEY, *Notary Public.*

183 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS.

UNITED STATES OF AMERICA, SOUTHERN DISTRICT OF NEW YORK, *ss.*

CHARLES F. CHANDLER, being duly sworn, deposes and says: I reside in the city of New York. I am 41 years of age; am a chemist by profession, and a professor of chemistry in the School of Mines in Columbia College, also in the College of Physicians and Surgeons, and in the New York College of Pharmacy; have for the past twenty-five years devoted my attention to chemistry, theoretical and applied to the arts; am familiar with the chemistry of dyeing and calico-printing; was educated at the Lawrence Scientific School, and at Göttingen and Berlin, spending in all about two years in German schools, where I received my degree. As editor of the *American*

The brilliant red color known as Turkey-red, using an oil mordant, is produced from madder, and has been known for generations.

No colors or shades of colors can be produced by the use of artificial alizarine which cannot also be produced from madder or the above preparations. It is a matter of experiment and experience to ascertain what colors will be produced from the different varieties of madder preparations or artificial alizarine using any given mordant; and this experience has to be acquired in dealing with artificial alizarine just as in dealing with different varieties of madder or its preparations.

In topical printing, the mordant and the alizarine are applied together to the cloth, and this method has been used for some years before the introduction of artificial alizarine. Madder ali-
181 zarine, or, as it was called in the trade, alizarine, being a preparation of madder, was and is used for that purpose, and artificial alizarine is now used also for that purpose. The artificial alizarine is in a very convenient form, and therefore is used for that purpose more than madder preparations. Its cheaper price also induces its use for topical printing, where there is a greater waste of coloring matter than there is in dyeing, but the same result in topical printing can be produced by the use of madder alizarine. Colors produced by the use of artificial alizarine are no more fast than those produced by madder. The colors produced by madder are absolutely fast, and nothing can be more permanent than they are.

(Signed) THOMAS WALSH.

Subscribed and sworn to this 15th day of April, in the year of our Lord 1878, before me, a notary public in and for said county of Middlesex, and resident in Lowell. Witness my hand and official seal.

[SEAL.] (Signed) GEORGE STEVENS,
Notary Public.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK }
vs. }
T. K. CUMMINS & Co. }

UNITED STATES OF AMERICA, }
Eastern district of Pennsylvania, } *ss.*

JAMES HUNTER, of Philadelphia, Pa., being duly sworn deposes and says: I am the same person who was examined as a witness by the complainant in the suit of the Badische
182 Anilin und Soda Fabrik *vs.* Hamilton Manufacturing Company, and the testimony which I then gave for the complainant I now affirm. When I was examined there was no counsel for the defendant present, and I was never cross-examined, and was never asked questions in respect to what I am now about to testify.

I have manufactured large quantities of garancine and madder extracts, and used them in my business, and I have also used large quantities of artificial alizarine, and I believe that I understand the value of all these products. Topical printing was largely carried on before artificial alizarine was introduced in the market, and the extract of madder was used for that purpose. The cost of the extract of madder, however, made the process comparatively expensive, and therefore its use was limited.

Artificial alizarine has been sold, however, cheaper, and by reason of that fact topical printing is more largely practised than it was with madder extract.

There is no effect, however, neither in color nor shade, which can be produced by artificial alizarine which cannot also be produced by some form of madder preparation, and the colors are equally fast whether they are produced by madder preparations or artificial alizarine.

In the use of either or any of these different preparations different shades of color are produced by different varieties, and that is as true with madder preparations as with artificial alizarine, and the manufacturers supply preparations suitable for producing different colors as they are needed.

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Sworn to and subscribed before me the 17th day of April, A. D. 1878.

SAMUEL B. HUEY, *Notary Public.*

183 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
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UNITED STATES OF AMERICA, SOUTHERN DISTRICT OF NEW YORK, *ss.*

CHARLES F. CHANDLER, being duly sworn, deposes and says: I reside in the city of New York. I am 41 years of age; am a chemist by profession, and a professor of chemistry in the School of Mines in Columbia College, also in the College of Physicians and Surgeons, and in the New York College of Pharmacy; have for the past twenty-five years devoted my attention to chemistry, theoretical and applied to the arts; am familiar with the chemistry of dyeing and calico-printing; was educated at the Lawrence Scientific School, and at Göttingen and Berlin, spending in all about two years in German schools, where I received my degree. As editor of the *American*

Chemist, as well as for the purposes of my lectures, I have given special attention to the literature of artificial alizarine obtained from anthracene, and have had occasion to make a special study of all that was written on the subject, in my capacity as chemical editor of "Johnson's Encyclopedia," for which I prepared, early in 1873, the articles "Alizarine," "Anthracene," "Calico-Printing," and "Dyeing;" and I read the publications as they came out in the original German. Have been for many years the editor of the *American*

184 *Chemist*. I have sometimes testified as an expert in matters of letters-patent relating to chemical subjects, and have made many investigations in chemical arts. I testified in the suit of "Badische Anilin und Soda Fabrik *vs.* James Higgins and others," in the southern district of New York, being called as an expert for the defendants; and preparatory to giving that testimony, I made a very extensive examination of the chemical literature relating to natural and artificial alizarine and their application in dyeing and calico-printing. In the suit of Higgins, I was examined before Prof. Morton was called as a witness, and the question whether artificial alizarine was a new composition was never presented to me. I have never until now had occasion to discuss the testimony of Prof. Morton.

The word "alizarine" was applied to the principal coloring matter of madder by Robiquet and Colin in 1826. They isolated the substance whose exact formula is now known, but did not discover its atomic constitution accurately. The name, however, they gave to it has been universally adopted by chemists, and to this day is employed to designate the substance which they produced, and which they described so that it can be recognized and identified by chemists.

In 1866, Strecker determined the true constitution of alizarine, which is represented by the formula $C_{14}H_8O_4$, and published it in his text-book on organic chemistry, entitled "Kurzes Lehrbuch," published in 1866. In every technical book on chemistry in which the word alizarine is defined down to 1868, it is substantially defined to be the body discovered by Robiquet and Colin, for which different formulas were proposed by different investigators, but the identity of which was never questioned.

In 1832, Dumas and Laurent discovered in coal-tar a hydrocarbon, $C_{14}H_{10}$, known as anthracene. Later Laurent, Anderson, and Fritzsche produced anthrachinone, which they did by substituting two atoms of oxygen for two atoms of hydrogen in anthracene, thus producing anthrachinone, whose formula is $C_{14}H_8O_2$.

185 Bayer about 1866 devised a process by which the hydrocarbon from which an aromatic compound is primarily derived can be determined. For this purpose he heated the body to be investigated with zinc dust, by which it was deprived of its oxygen, and reduced back to its parent hydrocarbon.

In 1868, Graebe & Liebermann exposed the alizarine of madder to the process of Bayer—that is, heated it with zinc dust, when it

revealed to them its parent hydrocarbon, which is anthracene. Having discovered that alizarine of the madder root is a derivative of anthracene, they invented a process for producing it artificially from this substance.

The process of converting anthracene into anthrachinone has been already devised by Laurent. They had, therefore, only to add two atoms of oxygen to the anthrachinone, already discovered, to produce alizarine, which they did by well known processes previously employed by others for similar purposes, and for which they obtained their various patents in 1868, and the patent in this suit in 1869.

Their process, however, never passed beyond the limits of experiment, as it was not practicable on a large scale, and they were soon obliged to give up their Prussian patent, because they were not able to prove that their process was in practical operation.

The process which forms the basis of the industry of to-day was invented first by Heinrich Caro, in 1869, and an English patent for that process was taken out by him in association with Graebe & Liebermann in that year. This invention made the manufacture a practical one, and whatever practical benefits have been derived have resulted from it.

This sulpho-acid process invented by Caro is not a simple equivalent for the process invented by Graebe & Liebermann, in which bromine and chlorine was employed, and was not known to be such equivalent at the time of the patent of Graebe & Liebermann. On the contrary, Graebe & Liebermann had attempted to produce alizarine by the use of sulphuric acid, and had failed to accomplish it, and had abandoned it under the belief that it was impossible, for reasons which
186 they have stated in their report at the Vienna Exhibition. The conditions of temperature under which these sulpho-acid processes are practicable were not known to chemists at that time, and were discovered by investigation and experiment by Caro. These conditions of temperature were incompatible with what Graebe & Liebermann believed to be the properties of anthrachinone.

These facts are so well known that Dr. Reimann, editor of *Farber Zeitung*, published in Berlin, and of the *Journal de Teinture*, which is the French edition of the same, made the following statement in his article "Farberei," in Muspratt's "Theoretische Practische Analytische Chemie," 2d vol. p. 1125, Brunswick, 1874 (one of the most complete and elaborate works on technical chemistry that can be found in any language, and one of the best authorities):

In speaking of the Graebe & Liebermann process, Reimann says:

"This method of preparation possesses only a purely theoretical interest. Graebe & Liebermann had so little success in manufacturing alizarine on a large scale by this process that they were soon obliged to give up the Prussian patent granted them, because the inventors were unable to prove that their process was in practical operation. The methods practically employed in the manufacture of artificial alizarine did not originate in the first place with Graebe & Liebermann."

I have read Graebe & Liebermann's original English patent of December 18th, 1868, and the original American of 1869, which is substantially a copy of it. The word alizarine used in these patents to describe the product of the processes therein specified, means that, so far as the product was a dye-stuff, it was chemically pure alizarine. The "yellow flocks" of alizarine precipitated by the reaction have every appearance of pure alizarine, and so far as that description identifies the product, it is a true description of the chemically pure alizarine. In the English provisional specification, Graebe & Liebermann leave no doubt of what they meant by saying that
187 alizarine prepared in this artificial way is "perfectly pure." I have read the forty-second question and answer of Professor Morton in his deposition in this case, in which he defines the words "perfectly pure alizarine," if interpolated in the American patent, and I agree with him that they mean chemically pure alizarine. But the discussion which arose after Graebe & Liebermann had stated their discovery and described their invention, leaves no room for doubt that they believed and asserted that the product of their patented process was chemically pure alizarine and nothing else, so far as it was a dye-stuff. In their report at the Vienna Exhibition, in which they gave a history of their invention, they make the following statement:

"The following equations represent the reactions which first give anthrachinone from anthracene, then bibromanthrachinone, and finally alizarine:

I. $C_{14}H_{10} + 3O = C_{14}H_8(O_2)'' + H_2O$.
Anthracene. Anthrachinone.

II. $C_{14}H_8(O_2)'' + 4Br = C_{14}H_6Br_2(O_2) + 2BrH$.
Bibromanthrachinone.

III. $C_{14}H_6Br_2(O_2)'' + 2KOH = C_{14}H_6(OH)_2(O_2)'' + 2KBr$
Alizarine.

The latter is of course contained in the alkaline fusion (Schmelze) as alizarate of potassium, $C_{14}H_6(OK)_2(O_2)$, and is precipitated by acids."

The equations given in this statement represent the reactions described in their patent of 1868, and the result of the third equation is pure alizarine, in the shape of alizarate of potassium, which, they say, will be precipitated by the use of acids. This precipitate consists of "yellow flocks," as they correctly describe it, and it indicated nothing but chemically pure alizarine. The intermediate steps omitted by Graebe & Liebermann, from the fact that they combine two equations under No. 3, are as follows, which any chemist will see at a glance:

$$C_{14}H_6B_2(O_2) + 4KOH = C_{14}H_6(OK)_2(O)_2 + 2KB_2 + 2H_2O.$$
$$C_{14}H_6(OK)_2(O_2) + H_2SO_4 = C_{14}H_6(OH)_2(O_2) + 2K_2SO_4.$$

188 Alizarine, if made as indicated in this formula, in "yellow flocks," is chemically pure before it is sublimed, and sublimation has no other effect upon it than to put it into a crystalline form, in which it can be identified by its appearance with the crystallized alizarine from madder.

There is nothing in the formulas given by Graebe & Liebermann that would indicate to a chemist or lead him to suspect the simultaneous formation of any other compound than alizarine.

So far as I know—and I have examined the literature carefully—there has been no statement made in any of the printed publications on this subject that anthrapurpurine is produced by the bromine process of Graebe & Liebermann's patent.

When, however, Graebe & Liebermann, at the Vienna Exhibition, made their report, and referred to the production of anthrapurpurine, they stated that it had been obtained from the sulpho-acid process.

One of the objections which was made to artificial alizarine when first introduced was that it was pure alizarine not containing any other coloring matter, as madder alizarine does, which objection was answered by showing that purpurine in madder was practically a useless constituent, and therefore that the absence of anything but pure alizarine was no objection to its use.

This is shown by the following language of Perkin, in his article published in the journal of the London Chemical Society of 1870, p. 140, a part of which is quoted by Prof. Morton in his deposition in this case to sustain a contrary poposition:

"Artificial alizarine has been objected to, as a substitute for madder, on the ground that pure alizarine will not produce madder colors, other coloring matters being required. Now, the only coloring matter in madder besides alizarine, which is not injurious to the beauty of the colors, is purpurine."

He then goes on to show that purpurine is useless, and says: "I have made some experiments also in this direction, and have
189 found nothing but alizarine in finished madder prints. I could not detect purpurine even with the spectroscope."

What is now called anthrapurpurine was discovered by Auerbach in a product not obtained by bromine or chlorine processes of Graebe & Liebermann, and he gave it the name of isopurpurine. In 1870 Perkin noticed a peculiar substance in commercial artificial alizarine made by the process of Caro, but did not obtain it in a perfectly pure state. Later, in 1872, he described it more fully and gave its analysis and constitution, and in 1873 he named it anthrapurpurine.

The two names, isopurpurine and anthrapurpurine, are simply different names for the same chemical compound, and not two distinct bodies, as stated by Prof. Morton in his testimony. Graebe & Liebermann, in their Vienna report, knew and state this fact, and Auerbach has published it to the world in his book on "Anthracene," p. 203, published in London in 1877.

Purpurine is found in madder in association with alizarine. Its formula is $C_{14} H_8 O_5$—that is, it has one more atom of oxygen than alizarine has. Its effect in dyeing, as the extract from Perkin shows, has been the subject of doubt and discussion, it being claimed on one side to be a valuable element and on the other side to be valueless. Its effect, however, when isolated and used as a dye, is well known,

and a comparison can be made between the colors it will produce and the colors that can be produced by anthrapurpurine. Anthrapurpurine, or isopurpurine, as it is sometimes called, has the same chemical formula as purpurine, and is distinguished from it, so far as it is a dyeing agent, by slight differences in the shades of color it will produce on mordanted cloth. These differences and other peculiarities which have no relation to its practical value or effect show that it is isomeric with purpurine.

Bodies are said to be isomeric when they contain the same elements in the same proportions, but do not in everything act alike, from which it is inferred that there is some difference in the arrangement of the atoms. Diamonds and plumbago are said to be iso-
190 meric, but there it no resemblance between the two. This illustration is at one end of the line. Purpurine and anthrapurpurine are said be isomeric, but the differences between them are very slight. Auerbach, one of the highest authorities on this subject, remarks that with mordants isopurpurine dyes shades between those of alizarine and natural purpurine.

When anthrapurpurine is produced by itself, it is a more valuable body than purpurine by itself, because it more nearly assimilates to alizarine in its fastness of color, but when it is combined with alizarine made by some of the sulpho-acid processes, of which there are now a considerable variety, the mixture will produce no results which cannot be obtained by madder preparations containing alizarine and purpurine.

In the affidavit of Prof. Morton in this motion it is stated that "artificial alizarine as a dye possesses new properties that were capable of producing, under identical conditions, effects differing from and superior to those obtained from madder and its preparations." If, by the words "identical conditions," it is meant, as I suppose it is, that the mordanted cloth shall be identical in both cases, or that in topical printing the mordants used shall be identical, then it may or may not be true in some particular case that the results of the artificial alizarine may be superior to those of natural alizarine, and it may be true that those results will be inferior. Under identical conditions, any two samples of madder preparations, if the madder has been produced in different parts of the world, or the preparations have been made by different manufacturers, will produce different results, one of which will be superior to the other; and the same is true of different varieties of artificial alizarine as compared with each other. In all cases, whether artificial or natural alizarine is used, it is necessary to adapt the conditions of use to the quality of dye in order to produce the desired results. If by "identical conditions" it is meant that artificial alizarine, as a general thing, will produce different and superior results to those obtained from madder preparations, when used in the manner best suited for their application, then than that statement is not true. On the contrary, each and
191 every result which can be obtained from artificial alizarine can be obtained from preparations of madder, and so true is

this in practice that, although artificial alizarine is sold very cheaply, yet print works are now using madder preparations which are more expensive than artificial alizarine, thus showing, to say the least, that there are no superior results to be obtained by artificial alizarine in the experience of men who spend their money to produce practical results.

I have carefully examined the Graebe & Liebermann patent in this case. There are no words, or set of words, in that patent which would convey to the mind of a chemist the idea that it described a composition of matter; on the contrary, it is explicit and precise in describing a perfectly intelligible process for producing a well-known substance called alizarine, and, in my judgment, no chemist who reads that specification can find any evidence in it that it is there proposed to produce any thing by that process but perfectly pure alizarine, which was a well-known substance in the world, and was generally considered to be the essential principle of the madder root, to which it owed its value as a dye-stuff; and when this patent is read in connection with Graebe & Liebermann's chemical formula, giving correct expression to the products of the process there described, it amounts to a demonstration that they intended nothing by the word *alizarine* but $C_{14} H_8 O_4$, the final product of the reactions described by them in their Vienna report. And when again, in their English patent, they use the words "perfectly pure alizarine," there is another affirmation of the same truth by them which equally excludes the idea that any thing else but $C_{14} H_8 O_4$ was the object and the result of their invention.

CHARLES F. CHANDLER.

Sworn to and subscribed before me this 24th day of April, 1878.

WILLIAM S. BEAMAN,
Notary Public, city and county of New York.

192 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS.

I, the undersigned, Gustav Auerbach, have since 1871 occupied myself extensively and exclusively with the scientific study and practical working of and researches about *madder and its derivatives* (garancine, alizarine and purpurine), and also *anthracene from coal tar and its derivatives, especially alizarine and isopurpurine* (for the latter also the synonym "anthrapurpurine" is used), and have published a monographie about it which all chemists know who are interested in these articles (1st edition 1872, at Seehagens, Berlin; 2d edition 1877, by Longman Green & Co., London).

After having studied at the University of Zurich, Switzerland, and specially worked there at the scientific laboratories of this city in

the above-mentioned direction, I entered September, 1872, as manager of the chemical laboratories and the practical works combined with it into the alizarine factory of Messrs. Gebruder Gessert, in Elberfeld, where I stayed two years, and then entered a similar position at the alizarine factory of Messrs. Brooke, Simpson &
193 Spiller in London, where, however, I had, besides the laboratories, also to conduct the technical management of the whole factory; and after these gentlemen sold their alizarine works to Messrs Burs Boulton & Haywood, in London, I remained in the same position with the latter firm.

Under my management these factories were much enlarged, and I had thereby the opportunity to work regularly in extensive production, so that I can justly claim to be fully acquainted with the theoretical and practical knowledge of the management of alizarine from madder, and the manufacturing of alizarine from anthracene, just as it is generally acknowledged that I am an authority about these points scientifically.

Having now of late become acquainted with the singular assertions of Professor Morton and other gentlemen in America, which they have brought forward as evidence in a patent case, and which were written and printed afterwards, I consider it my duty, in order to clear up the great mistakes and faults contained in their evidence, to declare energetically—and because this is necessary to bring my authority direct and irrefutable before these gentlemen—to witness this by my signature, and to swear that the whole contents of this document are true and nothing else but the truth!

1st. No chemist has so far ventured to allege that before the publishing of my treatise in the Moniteur Scientifique, 1872, N 368, page 686, he knew or had investigated anything about the fact that the alizarine made from anthracene contained any substance which possesses the chemical formula as purpurine from madder, viz.: C_{14} H_8 O_5, and which is isomeric with the latter.

See Gräbe & Liebermann's own acknowledgment of the above in their official report to the Vienna Exhibition, 1873, volume 3, part 1, 2 (Amtliche Berichte über die Wiener Weltausstellung, im Jahr, 1873; band III., abtheilung 1, 2), and the special extract of this, which Gräbe & Liebermann have edited: Vieweg & Sohn, Braunschweig, 1876, Seite 26 u. 27.

194 *I* have—in 1872—after discovering this body, given it the name of isopurpurine, and first made public to the scientific world the fact—which now is generally acknowledged—that the chemical formula of this isopurpurine is $C_{14}H_8O_5$, and therefore exactly the same as the chemical formula for purpurine from madder.

Perkin, who some time after my discovery published a treatise about the same body, adopted the name of anthrapurpurine for it, all further studies about it and repeated comparative analyses publications of authorities as p. e. Schunk and Roemer in Manchester, and above all comparative tests of anthrapurpurine made by Per-

kins and isopurpurine made by myself have proved distinctly the complete identity of these two preparations and also that they are isomeric with the purpurine contained in madder, which latter (purpurine) as is well known either appears in combination with alizarine from madder—or is extracted from it as a separate body—and that this isopurpurine (or as you may call it also, anthrapurpine) has exactly the some chemica. ormula as purpurine from madder, viz, $C_{14} H_8 O_5$!

Professor Morton must—u. intentionally or intentionally not have got an opportunity trustfully to inform himself or to study by reliable own researches the real fac., or he never could have given such errors as his opinion and evidence as those which in the alizarine case of the Badische Anilin & Soda Fabrik versus James Higgins & Co. as tried before the United States Court which pretend that there are two separate substances contained in alizarine from anthracene, viz: isopurpurine and anthrapurpurine, and that these were something altogether new and patented in 1869 and not isomeric with purpurine from madder.

2d. I can also assert based on my thorough experience, that it is another mistake of Mr. Morton if he pretends that all alizarine from anthracene must and will contain iso (anthra) purpurine.

195 On the contrary, it depends altogether on the manufacturing process whether this body is contained in the alizarine from anthracene or not.

Every manufacturer and chemist who has made alizarine on a large scale, will know that alizarine, not only in laboratory experiments but also in large quantities can be and is produced which corresponds with and represents the exact chemical formula of $C_{14} H_8 O_4$ and which does not contain any iso (anthra) purpurine.

It is evidently apparent from Professor Morton's opinion which pretends that all alizarine made from anthracene must contain isopurpurine, that this gentleman has either not sufficiently understood or worked though the details of the process by which alizarine out anthracene is formed; or that he only made so few experiments and researches that we must look upon his affirmations as careless, hasty and premature.

Perkins published a short time ago the details of the fact that from the anthraquinone besides the bisulphoacid of anthraquinone also monosulphoacid of anthraquinone, is produced (a fact which I was already acquainted with in 1872, but which I had to keep as a business secret.)

Now it being also an undisputable fact that monoanthraquinone sulphoacid, when melted with caustic soda, only yield alizarine and no iso (anthra) purpurine whatever and because this monoanthraquinone sulfoacid can be is easily produced chemically pure in any large quantities, the above assertion of Professor Morton that every alizarine out of anthracene contains iso (anthra) purpurine is absurd and void on its face.

The pure alizarine so gained from the monoanthraquinone sulfo-

acid is perfectly identical with the alizarine from madder, and is regularly produced in large quantities for the special purpose of dyeing and printing pink and purple shades on cotton.

3d. Professor Morton asserts that he has often made alizarine according to the specification of the patent, and by regulating or modifying the quantitative addition of soda or potash, he had been able to enlarge the proportionate quantity of iso (anthra) purpurine
196 resulting therefrom. This pretended result has, however, no alliance with and does not depend upon the greater or less addition of soda or potash, but lies in the nature of the patent and the heating points mentioned therein!

All patents taken out for the manufacturing of alizarine from anthracene gives a more or less high temperature for the treatment of the anthracene resp. the anthraquinos with sulfuric acid, with bromine and chlorine, etc., etc., by which sulphoacids resp. other substitutional products are formed, which, when afterwards fused or melted with potash or soda, yield higher hydroxilized anthraquinones!

All chemists who are acquainted and intimate with the manufacturing of alizarine from anthracene know that the quantity of soda or potash used for obtaining the alizarate of soda or potash has no influence on the end result.

A certain quantity of alkali is necessary for the following reasons:

1st. To neutralize the sulfurous acide which is formed during the melting process.

2d. To saturate the alizarine which is formed (obtained.)

So that by this manipulation two bodies result in the retort:

Sulfurous alkali and alizarate of soda or potash.

If in this melting process too little alkali is added, the process stops half way—viz., will not become perfect, and intermediate products are formed which have no dyeing properties!

A surplus of alkali added does, however, not do the slightest harm, because the alizarine which once has been formed during the melting process cannot again be afterwards converted into isopurpurine by an excess of alkali, as Professor Morton imagines it does!

4th. If this gentleman furthermore asserts that he is able by chemical means always to find out and to prove whether a piece of cloth has been dyed with alizarine made from madder or with alizarine made from anthracene, this is also a very great and evident mistake and error!

197 With yellowish shades of alizarine dyed or printed on cloth it seems Mr. Morton has made this argument plausible for himself! Such yellowish dyeing shades of alizarine from anthracene, however, contain more or less isopurpurine, and for this reason dye a more or less scarlet tint; but the argument is altogether wrong, because it is a well-known fact that madder or alizarine made from it contains (if not specially prepared to be pure alizarine) more or less purpurine, which, in the dyeing process, shows the same yellowish tints as yellow dyeing alizarine from anthracene.

Every intelligent printer or dyer will also confirm that for these

yellowish tints the Dutch madder was always preferred in the market on account of its containing more purpurine than the usual deliveries from Naples and Avignon; also, that the marena (the madder which is grown in the Caucasus of Russia) was always the elite for pink and purple dyeing, it being the purest madder existing, and containing the least purpurine.

The alizarine made from monosulfo acide of anthraquinone, which dyes the most blueish tints of alizarine from anthrocene, and is used largely for dyeing and printing pinks and purple shades, produces chemically pure alizarine, and shows, when dyed or pinted on cloth, exactly the same properties and results as pure alizarine from madder.

Finally I recapitulate again that the purpurine made from madder (in practical use and the strict chemical sense of the expression) is altogether identical with the purpurine made from anthrocene, of which not only samples but casks can be had at any time in New York at E. Sehlback & Co., or Boston at A. Cochrane & Co. (See Schunk & Romer's experiments herein, De Lallande and Rosenstiehl's, &c.)

All authorities have furthermore long ago settled the question that the isopurpurin contained in the yellowish dyeing alizarine from anthrocene (a product which results by melting the bisulf anthra-
quinonate of soda, or a mixture of the same, with monosulfo
198 anthroquinonate of soda and alkalis) is isomeric with the purpurine from madder.

Though I have chiefly made the above statements about the chemical constituents of isopurpurine, etc., (which in reality have nothing whatever to do with the validity of the patent, facts which were first published by me in 1872, and are fully acknowledged by the whole chemical world,) in order to refute and correct Prof. Morton's erroneous and false assertions, (because he not only made such assertions privately, but also published them and spread them abroad,) I cannot help finally adding the expression of my great and just surprise—how it is possible that those gentlemen, American experts—dare to claim for the article alizarine from anthracene—(or much more, for the process discovered by the inventors, and which was patented in 1869,)—as the most important substance through which they now want to prove the validity of the patent of 1869—the presence of isopurpurine in alizarine from anthracene—a substance which neither the inventors (Messrs. Graebe and Liebermann), nor other chemists knew anything of—until slightly over two years after they had taken the patent.

I have in 1872 first discovered, established the fact, traced the article itself and its chemical properties and published my discovery, which no one can deny, and Graebe and Liebermann confirm themselves by their treatise about the Vienna Exhibition, 1873.

(Amtliche Berichte über die Wiener Weltausstellung im Jahr 1873, Band III., abtheilung I 2, and the special extract from it published by Graebe and Liebermann, 1876, at Friederich Vieweg, & John Braunschweig.)

GUSTAV AUERBACH.

[SEAL.] Sworn and subscribed to in the consulate of the United States at Barmen, before me, this 25th day of March, 1878.

EDGAR STANTON, *U. S. Consul.*

199 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
v.
T. K. CUMMINS.

I, the undersigned, Carl Otto Neuhaus, merchant and alizarine maker in Elberfeld, in the kingdom of Prussia, and senior partner of the firm of Carl Neuhaus, alizarine maker, in Elberfeld, do hereby declare on oath that I have during the last five years conducted the business of making alizarine from anthracene; that I am intimately acquainted with every detail of the various processes for doing so.

I further declare that I consider it to be contrary to truth, as has been asserted by Prof. Morton in a recent trial in New York (Badische Anilin und Soda Fabrik *versus* James Higgins & Co.,) concerning alizarine patents, that all alizarines made from anthracene contain, besides pure alizarine according to the formula C^{14} H^{8} O^{4}, the same as alizarine prepared from madder root, certain bodies which, when dyed on alumina mordants, give yellowish reds.

I further declare that it is entirely under my control, when I make alizarine from anthracene, whether I obtain an alizarine perfectly pure and identical with alizarine prepared from madder root according to the formula C^{14} H^{8} O^{4}, and giving with alumina mordant a crimson red or pink, and with iron mordants a fine bright purple, or whether I obtain an alizarine mixed with impurities, giving with alumina mordants yellowish reds, and with iron mordants reddish
200 dull purples. These impurities are of various kinds, and I would say have been only partly investigated by chemists. Some say they are identical with purpurine as contained in madder. Perkin calls them anthrapurpurine. Auerbach calls them isopurpurine, but asserts that his isopurpurine is the same body which Perkin calls anthrapurpurine.

I further declare that I have regularly made, and am making now, this alizarine identical with pure alizarine from madder, which is largely used for making pinks and fine purples, and which is perfectly free from such impurities; and if Professor Morton asserts that he has frequently made alizarine from anthracene, and never failed to obtain these bodies—giving yellowish reds with alumina mordants—it seems that he has made only very few trials, insufficient to enable him to speak with any authority on this matter, or that he only imperfectly understands these processes.

If Professor Morton further asserts that the temperature and the quantity of caustic soda or potash in the melting or fusing process has any effect on the quantity of these bodies (dyeing yellowish reds with alumina mordants,) I can positively declare that I have never

obtained this result, and that it is *contrary* to my five years, experience as a practical alizarine-maker. A certain quantity of caustic soda or potash is necessary in the melting or fusing process, which quantity is well known to alizarine-makers. If this quantity is not taken, the *only* result is a lesser quantity of alizarine of soda or potash being formed; but I have made a great number of small and large experiments with additional quantities, taking as much as four times the quantity required, but have never obtained a result as Professor Morton says he invariably obtained, and I can positively assert that the temperature in the melting or fusing process, or the quantity of caustic soda or potash, has not that effect at all; but it is a fact well known to alizarine-makers, and to chemists who have studied this branch of industry, that the quantities of bodies dyeing with alumina mordant yellowish reds are dependent upon
201 certain changes in a previous process in the manufacture of alizarine from anthracene.

CARL OTTO NEUHAUS.

Elberfeld, 6th April, 1878.

Affirmed and subscribed to in the Consulate of the United States at Barmen, before me, this sixth day of April, 1878.

[SEAL.] EDGAR STANTON,
United States Consul.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

I, the undersigned, Carl Rumpff, a citizen of the United States, merchant and alizarine-maker in Elberfeld, in the kingdom of Prussia, and partner in the firm of Friedrich Bayer & Co., alizarine-makers in Barmen and Elberfeld, do hereby declare on oath that I have during the last five years conducted the busines of making alizarine from anthracene; that I am intimately acquainted with every detail of the various processes for doing so.

I further declare that I consider it to be contrary to truth, as has been asserted by Professor Morton in a recent trial in New York (Badische Anilin und Soda Fabrik *versus* James Higgins & Co) concerning alizarine patents, that *all* alizarines made from anthracene contain, besides pure alizarine according to the formula
202 $C_{14} H_8 O_4$, the same as alizarine prepared from madder root, certain bodies which, when dyed on alumina mordants, give yellowish reds.

I further declare that it is entirely under my control, when I make alizarine from anthracene, whether I obtain an alizarine perfectly pure and identical with alizarine prepared from madder root according to the formula $C_{14} H_8 O_4$, and giving with alumina mordant a crimson

red or pink, and with iron mordants a fine bright purple, or whether I obtain an alizarine mixed with impurities, giving with alumina mordants yellowish reds, and with iron mordants reddish dull purples. These impurities are of various kinds, and I would say have been only partly investigated by chemists; some say they are identical with purpurine as contained in madder. Perkin calls them anthrapurpurine. Auerbach calls them isopurpurine, but asserts that his isopurpurine is the same body which Perkin calls anthrapurpurine.

I further declare that I have regularly made and am making now this alizarine identical with pure alizarine from madder, which is largely used for making pinks and fine purples, and which is perfectly free from such impurities; and if Professor Morton asserts that he has frequently made alizarine from anthracene, and never failed to obtain these bodies—giving yellowish reds with alumina mordants—it seems that he has made only very few trials, insufficient to enable him to speak with any authority on this matter, or that he only imperfectly understands these processes.

If Professor Morton further asserts that the temperature and the quantity of caustic soda or potash in the melting or fusing process has any effect on the quantity of these bodies (dyeing yellowish reds with alumina mordants), I can positively declare that I have *never* obtained this result, and that it is *contrary* to my five years' experience as a practical alizarine-maker. A certain quantity of caustic soda or potash is necessary in the melting or fusing process, which quantity is well known to alizarine-makers. If this quantity is not taken, the only result is a less quantity of alizarate of soda or
203 potash being formed; but I have made a great number of small and large experiments with additional quantities, taking as much as four times the quantity required, but have never obtained a result as Professor Morton says he invariably obtained, and I can positively assert that the temperature in the melting or fusing process, or the quantity of caustic soda or potash, has not that effect at all; but it is a fact well known to alizarine-makers, and to chemists who have studied this branch of industry, that the quantities of bodies dyeing with alumina mordants yellowish reds are dependent upon certain changes in a previous process in the manufacture of alizarine from anthracene.

(Signed) CARL RUMPFF.

CONSULATE OF THE UNITED STATES
at Glasgow, Scotland.

Sworn to and subscribed before me this fifth day of April, A. D. 1878.

[SEAL.] SAMUEL F. COOPER,
Consul of the United States at Glasgow, Scotland.

204 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF MASS., COUNTY OF ESSEX, DISTRICT OF MASS., *p. e.*

JAMES HARLEY, of said Essex, being duly sworn, deposes and says: That he has been assistant superintendent of the Hamilton Print Works at Lowell, and now printing and dyeing on his own account in said state; that he has been engaged in the business of dyeing and calico printing for the last twenty-six years; that he is familiar with the use of madder and its preparations, and of artificial alizarine, as dyestuffs; that the introduction of artificial alizarine, as a dyestuff, has had a great and favorable effect upon the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than can be got by the use of madder or its preparations.

Furthermore, by the use of artificial alizarine calico printers are enabled to produce patterns and styles of prints which they were practically prevented from producing before its introduction, whereby the range and extent of desirable styles and prints have been immensly increased. Besides artificial alizarine has great superiority for topical printing over madder extract, in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing which formerly had to be produced by the dyebeck; that by use of artificial alizarine the printer can obtain better pinks, better reds, and better whites in robe styles, better shades and whites in dye work generally than can be obtained by use of madder or its preparations.

For dark chocolate, browns and blacks, madder preparations are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dyestuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both artificial alizarine and madder dyestuffs
205 produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplanted madder dyestuffs.

JAMES HARLEY.

Subscribed and sworn to before me this 27th day of April, 1878, at Boston, Mass.

[L. S.] GEORGE O. G. COALE,
Notary Public.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF RHODE ISLAND, COUNTY OF PROVIDENCE, DISTRICT OF , *ss.*

WILLIAM HARLEY, of said Providence, being duly sworn, deposes and says that he has been superintendent of the Hamilton Print Works at Lowell, and is now superintendent of the Allen Print Works at Providence, in said state; that he has been engaged in the business of dyeing and calico printing for the last twenty-nine years; that he is familiar with the use of madder and its preparations, and of artificial alizarine, as dyestuffs; that the introduction of artificial alizarine as a dyestuff has had a great and favorable effect upon the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than can be got by the use of madder or its preparations. To dye the genuine madder pink, which will resist strong soap, repeated washings, and exposure to light, it is necessary to use madder itself and not garancine. Genuine Turkey red must be dyed with madder, (or artificial alizarine,) garancine will not do; so garancine and madder are not precisely equivalent, though both owe their chief value to alizarine and
206 purpurine. I have never been able to procure an artificial purpurine made from coal tar, and have never known any such article to be used by others. For many purposes artificial alizarine is much more convenient than madder, garancine, or even extract of madder. Madder or garancine cannot be used for steam colors, because of the very small amount of color which they contain, and the very large amount of woody fibre and other insoluble matter. Extract of madder may be used for steam colors, but it does not work so well in printing, and it is very variable in the amount and purity of color; while artificial alizarine of a particular brand, I have found to be uniform in quality and always working well in printing and in the subsequent operations. With artificial alizarine I have been able to get particular effects, that it is very difficult to produce with madder alone, or any of its preparations. I have found the colors made with artificial alizarine capable of bearing, without injury, the severest treatment to which madder colors may be safely subjected; in fact artificial alizarine proves more unchangeable than some of the shades produced with madder, flowers of madder, or garancine.

Besides artificial alizarine has great superiority for topical printing over madder extract, in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing, which previously had to be produced by the dyebeck; that by the use of artificial alizarine, the printer can obtain better reds and better whites in robe styles, better shades and whites in dye work generally, than can be obtained by the use of madder or its preparations.

For dark chocolates, browns, and blacks, madder preparations are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dyestuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both said artificial alizarine and madder dyestuffs produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplanted madder dyestuffs.

WILLIAM HARLEY.

Subscribed and sworn to before me, at Providence, on this twenty-ninth day of April, A. D. 1878.

[L. S.] GILMAN E. JOPP,
Notary Public.

207 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

STATE OF MASSACHUSETTS, COUNTY OF BERKSHIRE, *ss.*

ROBERT SYKES, being duly sworn, deposes and says: That he is familiar with dyeing and calico printing, and has been practically acquainted with that business for twenty-eight years; that he is superintendent of the Freeman Manufacturing Company at North Adams, Massachusetts; that artificial alizarine and madder, and its preparations, are both used as dyestuffs in the print-works of said manufacturing company; that formerly he made his pinks by dyeing in the dyebeck with madder or garancine, but now he makes them by topical printing only, and with artificial alizarine; that he can make them cheaper with artificial alizarine than with madder or its preparations, because they require much less labor and dyestuff when made with artificial alizarine than when made with the other dyestuff; that with artificial alizarine he obtains at once a good color, and a clear white after printing and one soaping; that madder-dyed pinks require to be imprinted with the mordant, dunged, dyed, washed, soaped, tinned, cut, and soaped again to obtain good shades and clear whites; and that he must, when dyeing with madder, dye a much heavier shade of color than he really wants to get, because a considerable portion of the color is removed by the necessary processes which come after dyeing.

Deponent further swears: That madder extract is not as suitable for pinks as artificial alizarine, because it works rough and "drags" into the white; and further, that madder extract will not make all the shades of pink required in the market, as it always produces too much of a scarlet shade, and this objection does not apply to artifi-

cial alizarine; that artificial alizarine makes nice-looking prints, with but little labor.

Deponent further says: That he prefers garancine to artificial alizarine for heavy black patterns with iron mordants, as artificial alizarine does not give as full a color with iron mordants as the madder preparation, but gives better results with the alumina mordants than madder or its preparations.

Deponent further says: That he prefers to make Turkey-red cardinal with artificial alizarine; that they can be made with madder or its preparations, but then a great deal more labor and also "cutting down" are required, and the red would not be as rich as when made with artificial alizarine, but will be somewhat brownish.

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Deponent further says that he prefers artificial alizarine to madder and preparations of madder, as he gets better work from it and at less cost in labor; that they could not get along in his print-works without artificial alizarine, and continue to make the styles and effects which are now being produced there with artificial alizarine.

Deponent further says that artificial alizarine and madder dyestuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both artificial alizarine and madder produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplanted madder dyestuffs.

ROBERT A. SYKES.

Sworn to and subscribed before me this 26th day of April, 1878.

[L. S.] ARNOLD G. POTTER,
Notary Public.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.

STATE OF RHODE ISLAND, COUNTY OF KENT, DISTRICT RHODE ISLAND.

JOHN D'ARCY, of said Warwick, being duly sworn, deposes and says that he is superintendent of the Oriental Print-works at Apponaug in said state, and has been in such position for the past four years; that with such experience of the business of dyeing and calico printing as he has been able to obtain in the aforesaid four years, he believes that the introduction of artificial alizarine as a dyestuff has had a great and favorable effect upon the business of dyeing and calico printing; he believes that by its use calico printers obtain brighter shades of color and better and clearer whites than were formerly obtained by the use of madder or its preparations; he believes furthermore that by the use of artificial alizarine, calico printers are enabled to produce patterns which they

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were practically prevented from producing before its introduction, whereby the range and extent of desirable prints have been immensely increased; he believes also that artificial alizarine has great superiority for topical printing over madder extract in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing.

JOHN D'ARCY.

STATE OF RHODE ISLAND, ETC., COUNTY OF KENT, *ss.*

In Warwick, in said county, this 29th day of April, 1878, subscribed and sworn to before me.

Attest my hand and seal notarial this the day and year last above written.

[L. S.] SAM. W. CLARKE,
Notary Public.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.

STATE OF MASSACHUSETTS, COUNTY OF WORCESTER, DISTRICT OF , *p. e.*

JOHN METCALF, of said Worcester, being duly sworn, deposes and says that he was formerly dyer at the Richmond Print-works, Providence, R. I., and is now dyer for T. & J. H. Saunders' Print-works, Southbridge, in said state; that he has been engaged in the business of dyeing and calico printing for the last twenty-six years; that he is familiar with the use of madder and its preparations, and of artificial alizarine as dyestuffs; that the introduction of artificial alizarine has had a great and favorable effect upon the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than can be obtained by the use of madder or its preparations.

210 Furthermore, by the use of artificial alizarine calico printers are enabled to produce patterns and styles of prints which they were practically prevented from producing before its introduction, whereby the range and extent of desirable styles and prints have been immensely increased; besides artificial alizarine has great superiority for topical printing over madder extract in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing which previously had to be produced by the dyebeck; that by the use of artificial alizarine the printer can obtain better pinks, better reds, and better whites in robe styles—better shades in dye work generally—than can be obtained by the use of madder or its preparations. For dark chocolate, browns, and blacks madder prepara-

tions are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dyestuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both said artificial alizarine and madder dyestuffs produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplemented madder dye-stuffs.

JOHN METCALF.

COMMONWEALTH OF MASSACHUSETTS, *Worcester*, } *ss.*

SOUTHBRIDGE, *April* 30, 1878.

Personally appeared John Metcalf, who signed the above, and made oath that the above statement, by him subscribed, is true.

CALVIN A. PAIGE,
[L. S.] *Notary Public.*

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF RHODE ISLAND, COUNTY OF KENT, DISTRICT OF RHODE ISLAND.

Thomas Kelly, of Warwick, in said Kent county, being duly sworn, deposes and says that he is dyer at the Oriental Print Works at Apponaug, in said state, and has been actively engaged in
211 the business of dyeing for the last thirty-five years; that he is familiar with the use of madder and its preparations and with artificial alizarine as dye-stuffs; that the introduction of artificial alizarine as a dye-stuff has had a great and favorable effect on the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than could formerly be obtained by the use of madder and its preparations.

THOMAS KELLY.

STATE OF RHODE ISLAND, ETC., *County of Kent*, } *ss.*

In Warwick, in said county, this 29th day of April, A. D. 1878, Thomas Kelly subscribed the above in my presence, and made oath to the truth thereof.

Attest my hand and seal notarial this the day and year last above written.

SAM. W. CLARKE,
[L. S.] *Notary Public.*

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF MASSACHUSETTS, COUNTY OF WORCESTER, DISTRICT OF , *p. e.*

James Saunders, of said Worcester, being duly sworn, deposes and says that he has been engaged in the business of dyeing and calico printing for the last twenty-five years; that he is familiar with the use of madder and its preparations, and of artificial alizarine as dye-stuffs; that the introduction of artificial alizarine has had a great and favorable effect upon the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than can be obtained by the use of madder or its preparations. Furthermore, by the use of artificial alizarine calico printers are enabled to produce patterns and styles of prints which they were practically prevented from producing before its introduction, whereby the range and extent of desirable styles and
212 prints have been immensely increased; besides artificial alizarine has great superiority for topical printing over madder extract in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing which previously had to be produced by the dye-beck; that by the use of artificial alizarine the printer can obtain better pinks, better reds, and better whites in robe styles—better shades in dye work generally—than can be obtained by the use of madder or its preparations. For dark chocolates, browns, and blacks madder preparations are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dye-stuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both said artificial alizarine and madder dye-stuffs produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplanted madder dye-suffs.

JAMES SAUNDERS.

COMMONWEALTH OF MASSACHUSETTS, WORCESTER, *ss.*

SOUTHBRIDGE, *April* 30, 1878.

Personally appeared James Saunders, who signed the above and made oath that the above statement by him subscribed is true.

[L. S.] CALVIN A. PAIGE,
Notary Public.

tions are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dyestuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both said artificial alizarine and madder dyestuffs produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplemented madder dye-stuffs.

JOHN METCALF.

COMMONWEALTH OF MASSACHUSETTS, *Worcester*, } *ss.*

SOUTHBRIDGE, *April* 30, 1878.

Personally appeared John Metcalf, who signed the above, and made oath that the above statement, by him subscribed, is true.

CALVIN A. PAIGE,
[L. S.] *Notary Public.*

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF RHODE ISLAND, COUNTY OF KENT, DISTRICT OF RHODE ISLAND.

Thomas Kelly, of Warwick, in said Kent county, being duly sworn, deposes and says that he is dyer at the Oriental Print Works at Apponaug, in said state, and has been actively engaged in
211 the business of dyeing for the last thirty-five years; that he is familiar with the use of madder and its preparations and with artificial alizarine as dye-stuffs; that the introduction of artificial alizarine as a dye-stuff has had a great and favorable effect on the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than could formerly be obtained by the use of madder and its preparations.

THOMAS KELLY.

STATE OF RHODE ISLAND, ETC., *County of Kent*, } *ss.*

In Warwick, in said county, this 29th day of April, A. D. 1878, Thomas Kelly subscribed the above in my presence, and made oath to the truth thereof.

Attest my hand and seal notarial this the day and year last above written.

SAM. W. CLARKE,
[L. S.] *Notary Public.*

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

STATE OF MASSACHUSETTS, COUNTY OF WORCESTER, DISTRICT OF , *p. e.*

James Saunders, of said Worcester, being duly sworn, deposes and says that he has been engaged in the business of dyeing and calico printing for the last twenty-five years; that he is familiar with the use of madder and its preparations, and of artificial alizarine as dye-stuffs; that the introduction of artificial alizarine has had a great and favorable effect upon the business of dyeing and calico printing; by its use calico printers obtain brighter shades of color and better and clearer whites than can be obtained by the use of madder or its preparations. Furthermore, by the use of artificial alizarine calico printers are enabled to produce patterns and styles of prints which they were practically prevented from producing before its introduction, whereby the range and extent of desirable styles and
212 prints have been immensely increased; besides artificial alizarine has great superiority for topical printing over madder extract in being more easily worked, thus enabling the calico printer to produce many styles by the cheaper and more expeditious process of topical printing which previously had to be produced by the dye-beck; that by the use of artificial alizarine the printer can obtain better pinks, better reds, and better whites in robe styles—better shades in dye work generally—than can be obtained by the use of madder or its preparations. For dark chocolates, browns, and blacks madder preparations are still preferred, because those colors produced from madder are fuller and stronger.

Deponent further says that artificial alizarine and madder dye-stuffs cannot be substituted for each other with equally good results in producing all the various colors and shades of color which can be made with either, but that both said artificial alizarine and madder dye-stuffs produce some colors which are respectively characteristic, while at the same time it is true that artificial alizarine has to a large extent supplanted madder dye-suffs.

JAMES SAUNDERS.

COMMONWEALTH OF MASSACHUSETTS, WORCESTER, *ss.*

SOUTHBRIDGE, *April* 30, 1878.

Personally appeared James Saunders, who signed the above and made oath that the above statement by him subscribed is true.

[L. S.] CALVIN A. PAIGE,
Notary Public.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.
} In Equity.

CITY, COUNTY AND STATE OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

JOHN WRIGHT, being duly sworn, deposes and says that he is by occupation a color-mixer and calico-printer, and has been engaged in that business for eighteen years, and is now employed in that business at the Oriental Print Works in Rhode Island; that
213 he is familiar with the use of madder and the preparations of madder, and with artificial alizarine as dye-stuffs; that the introduction and use of artificial alizarine as a dye-stuff in the business of dyeing and calico-printing has enabled manufacturers to obtain brighter shades of color and better and clearer whites than could formerly be obtained by the use of madder and its preparations; that artificial alizarine is more easily worked in topical printing than madder extract, and enables us to produce many styles by the cheaper and quicker process of topical printing which, before we could get artificial alizarine, were only attempted by dyeing in the dyebeck, and then were not produced with such good results as we produced them with artificial alizarine; that artificial alizarine and madder dye-stuffs cannot be substituted for each other with equally good results in producing the various colors and shades of color which can be made with either, but that each produces some colors which are characteristic, respectively; while artificial alizarine has, moreover, supplanted madder dye-stuffs, to a large extent, in the business of dyeing and calico-printing.

Deponent further says that for chrome steam shades he much prefers artificial alizarine to madder or its preparations, the artificial alizarine giving brighter and more even shades. Since we have been using artificial alizarine we can also produce a greater variety of tints in chrome steam shades than we could ever produce with madder or its preparations.

Deponent further says that the introduction into use of artificial alizarine in dyeing and calico printing is the most important event which has occurred in that business during the period deponent has been engaged therein; that it has enabled the manufacturers to produce therewith new styles which were never known before the introduction of artificial alizarine, and which never were made with the use of madder or its preparations, and that if deprived of the use of artificial alizarine they could not, at the print-works where deponent is employed, continue to make the styles and effects in calicos which they have been making there with artificial alizarine.

Deponent further says that goods dyed with artificial alizarine are faster in color and stand soaping better than goods dyed with garancine; that madder and indigo colors are considered the types of fast

colors, and that if a color is found to resist the usual operations of soaping and washing, as well as those colors, it would be considered and accepted as a "fast" color, and no one would think of submitting it to severer tests to find out if it was yet faster than these standard colors.

JOHN WRIGHT.

Sworn to and subscribed before me this 2d day of May, 1878.

[L. S.] HOWARD PAYSON WILDS,
Notary Public, New York county.

214 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

STATE OF NEW HAMPSHIRE, COUNTY OF HILLSBOROUGH, *ss.*

BENJAMIN C. DEAN, being duly sworn, deposes and says: I reside in Manchester, N. H., and am superintendent of the print works of the Manchester mills in said city, and am acquainted with madder and its preparations as used in connection with calico printing, and also with the use of artifical alizarine, so called. Different brands of artificial alizarine are found to be adapted to the production of different shades or colors, the same as is the case with madder and its preparations grown in different localities. Which brand to use, in order to obtain the most desirable results, with any given mordant, can be ascertained only by trial and experiment. My experience has been that better general results in dyeing calico are obtained by using together in the dye both artificial alizarine and garancene, in certain proportions, than from the use of either of said dyestuffs by itself; and that by said use together a fuller and richer shade or color upon the same mordant is obtained, as well as securing thereby better whites, and at a less cost. There are, however, certain brands of artificial alizarine which have proved much superior to madder or its preparations for dyeing solid reds and pinks, which have come into extensive use within a few years, superseding almost entirely, for this purpose, madder and its preparations, as formerly employed therefor.

For topical printing artifical alizarine is much preferable to madder extract. It is cheaper, and as at present produced gives more desirable resutls, and at cheaper cost.

BENJ. C. DEAN.

STATE OF NEW HAMPSHIRE, COUNTY OF HILLSBOROUGH, *ss.*

On this second day of May, A. D. 1878, personally appearing Benjamin C. Dean, subscribed and made oath that the foregoing affidavit is true, before me.

[L. S.] WILLIAM R. PATTEN,
Notary Public.

215 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.
} In equity.

STATE OF NEW HAMPSHIRE, COUNTY OF HILLSBOROUGH, *ss.*

LOUIS E. PHELPS, being duly sworn, deposes and says: I am dyer at the print works of the Manchester mills, in Manchester, N. H., and am familiar with the use of madder and its preparations, as well as with the use of artificial alizarine, for the dyeing of calicos. While in dyeing different brands of artificial alizarine, as well as different varities of madder, grown in different localities, will, with the same printed mordant, under the same circumstances or conditions, produce different shades or colors, yet my experience has convinced me that the use of artificial alizarine, in the dye, in connection with madder or garancene, gives, for general work, better results in regularity, depth and tone of color, and clearness of whites, than can be obtained with either one of the aforesaid dyestuffs used by itself. For dyeing solid reds or pinks I consider certain brands of artificial alizarine which I have used more desirable than madder or its preparations in every respect, besides being more convenient for use and cheaper in cost.

LOUIS E. PHELPS.

STATE OF NEW HAMPSHIRE, COUNTY OF HILLSBOROUGH, *ss.*

On this second day of May, A. D. 1878, personally appearing Louis E. Phelps, subscribed and made oath that the foregoing affidavit is true, before me.

[L. S.] WILLIAM R. PATTEN,
Notary Public.

216 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.
} In equity.

COUNTY OF SUFFOLK,
District of Massachusetts, } *ss.*

STEPHEN P. SHARPLES, of the city of Cambridge, in said district, being duly affirmed, deposes and says that on the 25th day of April, 1878, he went to the office of A. Cochrane & Co., at No. 55 Kilby street, Boston, and asked the clerk in charge if they had purpurine. He replied, "No;" that deponent further asked the clerk if they had ever had any purpurine, and he replied that they had not, and turned to another clerk and asked him the same question, and said other clerk replied thereto that they had never had any; that deponent explained to the clerk first named that he meant purpurine prepared from anthracene, and said clerk replied that he understood what deponent meant, and that they had never had it.

Deponent further says that on the first day of May, 1878, he, deponent, went to the place of business of Sellbach & Co., Milk street, Boston, and asked a clerk in charge there if they had purpurine. He replied they had not. Deponent then further asked him if they had ever had purpurine. He replied that some years ago they kept an aniline color called purpurine, for use on wool, but there was so little demand for it that they did not now keep it; and in answer to the question if they ever kept purpurine made from anthracene, he replied that they did not keep it, and never had kept it.

S. P. SHARPLES.

Subscribed and affirmed to, under the pains and penalties of perjury, this first day of May, 1878, at Boston, Massachusetts, before me.

[L. S.] J. RUSSELL BRADFORD,
Notary Public.

217 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

STATE OF MASSACHUSETTS,
County of Berkshire, } *ss.*

JOHN PARKHILL, being duly sworn, deposes and says: I am superintendent of the dyehouse of the Johnson Manufacturing Company at North Adams, Massachusetts; I am practically acquainted with dyeing yarn, and have been connected with the business for twenty-five years; I have used madder and its preparations and artificial alizarine; I cannot use madder or its preparations for producing the clear, pure shades of red and pink, but have to use artificial alizarine altogether for these shades of colors required; madder and its preparations give me too heavy dull shades.

JOHN PARKHILL.

Subscribed and sworn to before me this 7th day of May, 1878.

[L. S.] S. H. FAIRFIELD,
Notary Public.

218 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS. } In Equity.

STATE OF MASSACHUSETTS,
County of Berkshire, } *ss.*

A. B. MOLE, being duly sworn, deposes and says: I am superintendent of the Renfrew Manufacturing Company, at Adams, Mas-

sachusetts; I am practically acquainted with dyeing yarns for ten years; I have used madder and its preparations and artificial alizarine. For dyeing extra heavy reds for hosiery goods I prefer to use madder, as it gives me a fuller, deeper red than artificial alizarine. For ordinary reds and pinks I prefer to use artificial alizarine, as it gives clearer, brighter color with less labor than madder, as per samples attached herewith, which have been dyed under my supervision.

A. B. MOLE.

Subscribed and sworn to before me this 7th day of May, 1878.

[L. S.] H. H. WELLINGTON,
Notary Public.

This sample was dyed with Madder and treated in the same manner as the other, dyed with artificial Alizarine.

Swatch of yarn died with Madder.	Swatch of yarn dyed with artificial Alizarine.

This sample was dyed with artificial Alizarine, and was subjected to the same treatment as the other sample, dyed with Madder.

219 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS. } In Equity.

STATE OF MASSACHUSETTS,
County of Berkshire, North Adams, } *ss.*

ROBERT A. SYKES, being duly sworn, deposes and says: That I made an affidavit in this suit on the 26th day of April, 1878; that annexed hereto are four swatches of cloth dyed by me as follows, namely: the swatches marked *A* and *A'* were dyed with artificial alizarine, the swatches marked *B* and *B'* were dyed with garancine. The swatches marked respectively *A* and *B* and *A'* and *B'* were taken from the same pieces of mordanted cloth; each swatch after dyeing was washed. These swatches show that artificial alizarine gives bet-

ter whites, clearer colors, and different shades than the madder dyestuff garancine with the same mordants.

ROBERT A. SYKES.

Subscribed and sworn to before me this 7th day of May, 1878.

[SEAL.] S. H. FAIRFIELD,
Notary Public.

[Four swatches marked respectively *A*, *B*, *A'*, *B'* attached.]

220 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS. } In Equity.

SOUTHBRIDGE, COUNTY OF WORCESTER, STATE OF MASS., *ss.*

JAMES SANDERS, being duly sworn, deposes and says that he made an affidavit in this suit on the thirtieth day of April, 1878, before Calvin A. Paige, notary public; that annexed hereto are six swatches of cloth dyed at deponent's works; the swatch marked *D* is dyed with madder dyestuff known as garancine; the swatch marked *G* is dyed with artificial alizarine and garancine mixed together; these two swatches were mordanted in the same manner; the swatch *O* is dyed with madder dyestuff known as garancine; the swatch *F* was dyed with artificial alizarine and garancine mixed; the swatch *L* was dyed with artificial alizarine and garancine mixed together; swatch *N* with garancine; each swatch corresponding with each other are mordanted respectively the same; each swatch went through the usual washing and cleaning process; these swatches show that wherever artificial alizarine is used mixed with madder dyestuffs known as garancine, gives better results than madder dyestuff alone; that artificial alizarine gives different shades of colors, with the same mordants, from the shades produced by the madder preparations, as the swatches below will show in the reds, whites, chocolates and oranges.

JAMES SANDERS.

COMMONWEALTH OF MASS. WORCESTER, *ss.*

SOUTHBRIDGE, *May* 8, 1878.

Personally appeared before me James Sanders, who signed the above and made oath that the same is true.

[L. S.] CALVIN A. PAIGE,
Notary Public.

D Garancine.	Swatch D.	Swatch L.	L Was dyed with garancine and artificial alizarine mixed.
G Garancine and artificial alizarine mixed.	Swatch G.	Swatch N.	N Dyed with garancine.
O Dyed with garancine.	Swatch O.	Swatch F.	F Died with artificial alizarine and garancine mixed.

221 United States States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

SOUTHBRIDE, COUNTY OF WORCESTER, STATE OF MASS., *ss.*

JOHN METCALF, being duly sworn, deposes and says that he made an affidavit in this suit on the thirtieth day of April, 1878, before Calvin A. Paige, notary public; that annexed hereto are three swatches of cloth, two of which were dyed at Richmond Print Works, as follows, namely: the swatch number one (1) and two (2) were steamed with artificial alizarine, the swatch marked three (3) was dyed with madder dyestuff mordanted in the same manner, each swatch was subjected to the same treatment of washing and soaping (swatches number one and two, artificial alizarine, were steamed, and number three was dyed with madder dyestuff). These swatches show that artificial alizarine gives better and brighter pinks than madder. The number three (3) was dyed at Crompton Print Works by myself, and the numbers one and two also steamed by myself at the Richmond Print Works. These swatches show that artificial alizarine gives different shades of colors with the same mordants from the shades produced by the madder preparation as in the light and dark ground of these pinks, besides better and clearer whites.

JOHN METCALF.

COMMONWEALTH OF MASS., WORCESTER, *ss.*

SOUTHBRIDGE, *May* 8, 1878.

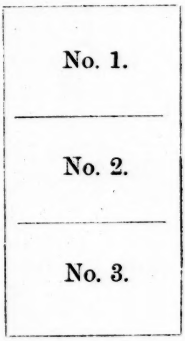
Personally appeared before me, John Metcalf, who signed the above and made oath that the same is true.

[L. S.] CALVIN A. PAIGE,
Notary Public.

No. 1.
Steamed Pink with artificial alizarine.

No. 2.
Steamed Pink with artificial alizarine.

No. 3.
Dyed Pink with madder dyestuff.



222 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.
} In equity.

STATE OF PENNSYLVANIA, CITY AND COUNTY OF PHILADELPHIA, *ss.*

THOMAS SMITH, being duly sworn, according to law, deposes and says:

I am a calico printer at Germantown, Philadelphia. I am proprietor of the Wister Print Works, Germantown. I have been proprietor for twenty-five years. I have been a proprietor and manager for over forty years.

I use now in my works the artificial alizarine dyes. Many years ago I used to use madder and its preparations. I know what madder is and what alizarine is. They are not the same thing. If madder be used alone, it will make a darker shade than alizarine. If sumac be used with madder, it will make it brighter. Alizarine will do with a weaker mordant than madder and its compounds. As a steam color, the alizarine is superior. It will act when madder will not.

The alizarine is a little cheaper; the processes with it are somewhat more rapid than with madder and its compounds.

Some colors can be made with alizarine that cannot be made with madder. Blue for instance. A drab can also be made with the artificial alizarine. It cannot be made with madder. I annex a sample marked *A*.

THOMAS SMITH.

Sworn and subscribed before me this 8th day of May, 1878.

[L. S.] EDWARD F. PUGH,
Notary Public.

Exhibit A.

E. F. P.,
Notary.

223 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN UND SODA FABRIK
vs.
T. K. CUMMINS. } In equity.

STATE OF PENNSYLVANIA, CITY AND COUNTY OF PHILADELPHIA, *ss.*

PHILIP L. FOWLER, being duly sworn, according to law, deposes and says:

I am superintendent of the Gloucester Gingham Mills of Gloucester, New Jersey. I have been such for six years. Before that I was general manager of A. Campbell's Mills, of Manyunk. I was there for two years. I have been in the color business for about thirty years.

I know something of madder and its compounds though I am not very familiar with them. I know artificial alizarine. The alizarine makes more permanent shades than the madder or compounds. Alizarine is a different article from madder or its compounds.

There are some processes which can be made with alizarine, which cannot be made with madder or its compounds. For example, steaming. Also most any color can be made with alizarine. They cannot all be made with madder; at least I do not know of any way to make some of them. Blue cannot be made with madder. Grey can be made with alizarine. I never saw any made with madder. I don't think it could be made with madder. I consider that there is no comparison to be made between the two, so far as our work is concerned. We could not use madder to any advantage at all. The process by using the alizarine is very simple. It is shorter than the madder process. The kind of work which we do usually is making Turkey reds. Made with alizarine, the color is perfectly fast. It cannot be stripped with acids. We made a test of it, the other day, with chemic standing 20, vitriol standing 18. It scarcely dulled the color at all. I have never seen any done with madder which would

stand such a test. I have no sample of the stuff which I tried. I have sent it all away.

With the alizarine shades can be changed very easily. It cannot with madder.

PHILIP H. FOWLER.

Sworn and subscribed before me this 9th day of May, 1878.

[L. S.] EDWARD F. PUGH,
Notary Public.

224 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS. } In equity.

CITY AND COUNTY OF PHILADELPHIA,
State of Pennsylvania, } *ss.*

THOMAS LONGSHAW, being duly sworn according to law, deposes and says:

I am thirty-four years of age. I live in the city of Philadelphia. I am a boss dyer with James Smith, manufacturer of ginghams, No. 1920 Pine street, Philadelphia. I have been there three years in that capacity. Before that I was with the Avamingo Mills, Frankford; I was a boss dyer there; I was there in that capacity for two years. Before that I was with Messrs. Ogden & Brothers, Paschalville. I have been a boss dyer for about fourteen years.

I am familiar with the use of madder and its preparations as a dyestuff; I am also familiar with artificial alizarine as a dye. Artificial alizarine is not the same as madder or the preparations of madder. Artificial alizarine dyes a brighter red than madder, and it is fast. Both madder and the alizarine are termed fast colors, but alizarine is the faster. It is also brighter. The white is more clear; that is to say, the dye of the alizarine does not run into the white, as it does with the madder.

Another advantage is that with the alizarine we can dye the red in the warp. There was never dyed any one with madder in the warp. I am very familiar with alizarine; I pretty much brought it out in yarn dyeing. The alizarine enables us to dye cheaper than we can do with madder. We can dye faster with it—about a third faster—than with the madder.

Madder is a flatter shade than the alizarine in its effects; it is more of a tawny or brownish shade. The one cannot be substituted for the other so as to produce the same effects. They are two different articles altogether.

A great many different shades can be made with the alizarine; purples, blacks and pinks. Shades of color made with madder or its preparations are not so bright as with the alizarine.

I annex a sample of goods dyed with the artificial alizarine. I

have none with me of madder dyes. The fact is, that madder dyeing is going out and we do little or none of it. We can use the alizarine to better advantage.

When Turkey red is dyed with madder or its preparations, it is a long and expensive process. I can produce the same shade with alizarine. Some people call the red of the sample which I have annexed, Turkey red. I call it alizarine red.

225 Reds used to be dyed with barwood, but the color is duller than that of alizarine and is not so fast.

I have used garancine, but never had so much experience with that as I have with madder. The shades obtained from the garancine were not so bright as those from the alizarine, and I could not get it even. The color was uneven—heavier in one place than in another.

I believe I have given all the distinctions which I can recollect, between the alizarine and the madder dyeing.

THOS. LONGSHAW.

Subscribed and sworn to before me this 7th day of May, A. D. 1878.

EDWARD F. PUGH,
Notary Public.

[L. S.]

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.
} In equity.

STATE OF PENNSYLVANIA, CITY AND COUNTY OF PHILADELPHIA, *ss.*

CHARLES E. WILD, being duly sworn according to law, deposes and says:

I am superintendent of the Eddystone Print Works, Chester, Pennsylvania. I take general charge of the practical operations of the business at the works. I have been there in that capacity three years and a half. Before that I was employed by the same firm for about fifteen years, in different capacities about the works.

226 I am not familiar with the composition of dyestuffs, but only with the practical results produced by them. We use madder and its preparations at our works. We also use artificial alizarine. We use the preparations of madder, such as garancine, for dyeing chocolates. That is all that we use them for. We use the artificial alizarine for steam and dyed reds; also for oranges—steam oranges. The alizarine used for steaming oranges is especially prepared for that purpose.

We don't substitute madder preparations for the alizarine. Each has a special work to perform. We never have tried to substitute one for the other except once, when we tried to substitute alizarine for garancine. The experiment was not then successful. We have never substituted garancine for alizarine. In practice we dye different colors with the madder preparations and the artificial alizarine, but we dye the same fabrics. The fabrics are calico prints.

We do not dye in the warp at all at our mills.

Reds used to be dyed with madder and its preparations, but since alizarine has become used in the market it has been used generally for this purpose. At least that is my impression.

I am not a chemist, and I do not know whether the constituent parts of the alizarine and the madder preparations are the same or different. I only know the practical results.

Mourning prints are our specialties, and therefore I am not as familiar with colors as I would be if we did the greater part of our business in colors.

I produce and annex four exhibits, whereof *A* and *C* are steamed with alizarine, *B* is dyed with alizarine, and *D* is dyed with garancine.

CHARLES E. WILD.

Sworn and subscribed before me this 8th day of May, 1878.

[L. S.] EDWARD F. PUGH,
Notary Public.

Exhibit A.	Exhibit B.	Exhibit C.	Exhibit D.
E. F. P.,	E. F. P.,	E. F. P.,	E. F. P.,
Notary.	*Notary.*	*Notary.*	*Notary.*

227 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

COUNTY OF PROVIDENCE, STATE OF RHODE ISLAND, *ss.*

WILLIAM HARLEY, being duly sworn, deposes and says that he made an affidavit in this suit on the twenty-ninth day of April, 1878, before Gilman E. Pope, notary public; that annexed are two swatches of cloth dyed by deponent in the month of November, 1873, or thereabout, in this year, as follows, namely, the swatch marked *A* was dyed with garancine, known as madder dyestuffs; the swatch marked *B* was dyed with garancine and artificial alizarine mixed together, both swatches were mordanted in the same manner, each swatch after dyeing was subjected to the same treatment of washing and soaping. These swatches show that artificial alizarine and madder dyestuffs (garancine) mixed together gives better results than madder dyestuffs alone; that the swatch marked *B* dyed with artificial alizarine and mixed together with garancine, known as madder dyestuffs, shows better and clearer whites, brighter reds and orange, although in swatch *A* there is mo. yellowing matter than *B*; the chocolates in swatch *B* show darker and deeper shade; that artificial alizarine gives different shades of color with the same mordants from the shades produced by the madder preparation.

WM. HARLEY.

STATE OF RHODE ISLAND, ETC., PROVIDENCE, *ss.*

In Providence, in said county, on the 9th day of May, A. D. 1878, subscribed and sworn to before me.

[L. S.] CORNELIUS C. PLUMMER,
Notary Public.

Swatch A.	Swatch A. Garancine madder dyestuffs alone, 1½ lbs. berries; 1 lb. aurantine, equal proportions.
Swatch B.	Swatch B. Artificial alizarine and garancine madder dyestuffs mixed together, 2 lbs. berries, equal proportions.

Date: 9 May, 1878.

WM. HARLEY.

228 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.
} In equity.

STATE OF NEW YORK, CITY AND COUNTY OF NEW YORK, *Southern district of New York,* } *ss.*

PETER MCTAGUE, being duly sworn, deposes and says: That he has been acquainted with the art of dyeing and calico printing for twenty-four years; that for about eleven years last past he was in the employment of the Hamilton Manufacturing Company at Lowell, Massachusetts, as dyer and calico printer. Deponent further says that he resides at Lowell, Massachusetts. That he is familiar with madder and its preparations and artificial alizarine as dye-stuffs; that madder and its preparations cannot be substituted for artificial alizarine in dyeing and calico printing with equally good results; that artificial alizarine produces brighter shades of color and better and clearer whites than can be obtained by the use of madder and its preparations, and that deponent has found it impossible to obtain with madder or its preparations all the shades of colors which are produced by the use of artificial alizarine; that artificial alizarine has driven out from use madder and its preparations to a great extent, because it produces better shades of color and clearer whites, and because calico printers are enabled by artificial alizarine to produce styles of goods which cannot be produced by the use of madder or its preparations.

Deponent further says that colors produced by garancine do not resist soaping as well by far as those produced with artificial alizarine; that his duties as dyer at said print works were to determine what dye-stuffs to use to produce the colors and shades required in any patterns; that for some styles he would have to use artificial alizarine alone, and for some other styles he would use artificial alizarine and garancine mixed together in different proportions according to the effects desired. In producing various colors I would use as follows: For chocolates I would use a larger proportion of garancine than of artificial alizarine, because in that way I would get a fuller chocolate; for patterns with orange and brown or orange and drabs, I would use very little garancine and a larger proportion of artificial alizarine, because I would thus get a brighter orange and clearer brown and drabs. For robe styles I use two parts of artificial alizarine to one part of garancine, and thus obtain clearer whites and better oranges and reds than if I used garancine
229 alone, the entire effect being thus much improved; for purples I use artificial alizarine alone and obtain brighter and clearer shades than with madder or its preparations; for light patterns of aniline black and reds I use artificial alizarine alone, and thereby I obtain clearer whites, better reds, and preserve the aniline black, which I could not do with madder, garancine or madder ex-

tract; for simple reds I prefer to use artificial alizarine alone. I have tried to do this style, simple reds, with garancine alone, and also with garancine and artificial alizarine mixed, but in neither case obtained the bright and clear color that I do in using artificial alizarine alone.

For black and red cardinals I use artificial alizarine. When deprived of the use of artificial alizarine I have attempted to do these styles (black and red cardinals) with madder extract, considering it the most likely of the madder prepartions to produce a good effect, but I failed, the red not being the shade I wanted nor as bright and the whites were very poor. For madder black and red I used garancine and artificial alizarine mixed. With garancine alone I obtained poor blacks, reds, and whites, whereas with a mixture of garancine and artificial alizarine I obtain good blacks and reds and a clear white. I annex six sheets with sundry swatches dyed by me at the Hamilton Manufacturing Company's print works, said swatches being pieces cut off from the prints made and sold by said company, viz:

Sheet A containing seven swatches.

Swatch 1 is dyed with madder.

Swatch 2 is dyed with artificial alizarine.

The shades and the white of No. 2 are much clearer than those of No. 1.

Switches 3 and 5 are dyed with madder.

Swatches 4, 6 and 7 are dyed with garancine and artificial alizarine mixed.

The shades of Nos. 4, 6 and 7 are brighter and the whites clearer.

Sheet B containing six swatches.

Swatches 8, 10 and 12 are dyed with garancine alone.

Swatches 9, 11 and 13 are dyed with artificial alizarine and garancine mixed.

The shades of Nos. 9, 11 and 13 are again brighter and the whites clearer.

Sheet C containing seven swatches.

Swatches 14 and 16 are dyed with garancine alone.

Swatches Nos. 15 and 17 are dyed with garancine and artificial alizarine mixed.

Nos. 15 and 17 show very brilliant oranges, bright reds and clear whites.

Swatch No. 18 is dyed with garancine alone.

Swatches Nos. 19 and 20 are dyed with garancine and artificial alizarine mixed.

The red of Nos. 19 and 20 is brighter and the whites are clearer.

230 *Sheet D* containing four swatches.

Swatch No. 21 is dyed with garancine alone.

Swatch No. 22 is dyed with garancine and artificial alizarine mixed.

No. 22 has a brighter appearance, the orange and red are better, and the white is clearer than that of No. 21.

Swatch No. 23 is dyed with madder.

Swatch No. 24 is produced with artificial alizarine by means of topical printing. The value of artificial alizarine is here strongly brought out.

In the case of No. 23 I have to dye with madder very dark shades, and then follow a long and tedious process in order to produce tolerably good shades and clear whites. The goods have to be imprinted with the mordant, dunged, dyed, washed, soaped, treated with acid, washed, and soaped again. Much dyestuff is thus lost, probably fully two thirds, whereas the process of producing with artificial alizarine the effects as shown in No. 24, is very economical and simple, the goods being simply printed, steamed, and soaped.

Sheet E containing five swatches.

Swatch No. 25 is dyed with madder.

Swatches Nos. 26 and 27 are aniline black, and the red dyed with artificial alizarine.

The red of Nos. 26 and 27 is much brighter and the black better than that in No. 25. I tried to substitute madder for artificial alizarine to produce the pattern of No. 27, but the red was dull and the white poor.

Swatch No. 28 was dyed with a mixture of garancine and artificial alizarine.

Swatch No. 29 was dyed with artificial alizarine alone.

In No. 29 the red is brighter and the white clearer than in No. 28.

Sheet F containing three swatches.

Swatches Nos. 30, 31, and 32. In these swatches the black is aniline black, and the red is dyed with artificial alizarine. No such good effects can be produced with madder or any of its preparations.

PETER McTAGUE.

Subscribed and sworn to before me this 10th day of May, 1878.

[L. S.] W. HAUFF,
Notary Public.

[Seven sheets of swatches.]

231 Circuit Court United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

LOWELL, COUNTY OF MIDDLESEX, STATE OF MASSACHUSETTS, *ss.*

JAMES HARLEY, being duly sworn, deposes and says that he made an affidavit in this suit on the twenty-seventh day of April, 1878, before Geo. O. G. Cole, notary public; that annexed hereto are six

swatches of cloth dyed by deponent as follows: the swatch marked *A* is steamed with artificial alizarine; the swatch marked *B* was dyed with matter dyestuff; the swatch marked *C* was dyed with artificial alizarine; the swatch marked D was dyed with matter dyestuff; the swatch marked *E* was dyed with matter dyestuff known as garancine, and the swatch marked F was dyed with artificial alizarine and madder dyestuff known as garancine. Each swatch went through the usual washing and cleaning process. These swatches show wherever artificial alizarine is used alone or mixed with matter dyestuff known as garancine better results are obtained than by madder dyestuffs used alone. Artificial alizarine gives different shades of colors with the same mordants from the shade produced by the madder preparation. The swatches below show that the pinks, reds, and purples, as also whites done with artificial alizarine, are far superior in shade and brilliancy to those done with madder dyestuff.

JAMES HARLEY.

A Steamed Pink with Artificial alizarene.	Swatch A.	Swatch C.	C Purple dyed with Artificial alizarene.
B Dyed Madder Pink.	Swatch B.	Swatch D.	D Madder Purple dyed with madder.
E Dyed with Madder dye-stuff known as Garancine.	Swatch E.	Swatch F.	F Dyed with Madder and Artificial Alizarine mixed.

232 COMMONWEALTH OF MASSACHUSETTS, MIDDLESEX, *ss.*

LOWELL, *May* 10, 1878.

Then personally appeared before me the undersigned, a notary public in and for said county of Middlesex, the within named James Harley, personally known to me to be the person he represents himself to be, and made oath that the statements in the within affidavit contained are true according to his best knowledge and belief.

In witness whereof, I have hereunto set my hand and affixed my notarial seal the day and year first above written. (The word 'Essex' erased and the word 'Middlesex' inserted in the place thereof at the first page of the affidavit before signing.)

[L. S.]

JOHN McEVOY,
Notary Public.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

JERSEY CITY, STATE OF NEW JERSEY, DISTRICT OF NEW JERSEY, *ss.*

ARNO BEHR, being duly sworn, deposes and says:

I am thirty-one years of age and am a native of Germany, where I followed a course of studies in the Universities of Heidelberg, Leipzig and Berlin; I am a chemist by profession and have made organic chemistry a special study. In the year 1873 I was an assistant teacher in organic chemistry in the Royal Politechnical Institute in Berlin under Prof. Liebermann, and am familiar with the literature of artificial alizarine, which was invented by Græbe and Liebermann, and am familiar with the method of its production; in the year 1874 I published, in connection with W. A. Van Dorp, some original investigations relating to the chemical constitution of anthracene and anthraquinon. Since the latter part of 1874 I have resided in the United States, and have been since that time and still am the chemist for F. O. Matthiessen & Wiechers Sugar Refining Co., Jersey City.

All the scientific authorities concur in the belief that Græbe and Liebermann are the first and original discoverers of artificial alizarine. A chemical process of so complex a nature as the formation of alizarine from anthracene has to be carried out in different steps by means of successive chemical reactions. Now it is known that in some reactions we may substitute one material for another with the same final result.

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In Græbe and Liebermann's invention an important step is the substitution in anthraquinon of two atoms of hydrogen (H_2) by two hydroxyls (2OH.) They effected this substitution by means of bibromanthraquinon, a new substance, which they themselves first made in making their invention.

In cases where it was the object to replace hydrogen by hydroxyl in certain aromatic substances, it was known that sulfo-acid compounds had been used successfully to effect this substitution. When Græbe and Liebermann made use of the bromine compound in this reaction they did so, I have no doubt, because it promised to them the quickest result, and because one of them, Græbe, was especially familiar with a similar class of bodies which he had studied in his researches about quinon derivatives. It ought to be kept in mind that at the time of their invention anthracene and anthraquinon were very rare and costly substances, and the object of the inventors was in the first place to arrive at and prove the scientifically interesting fact in their result, viz., the production of alizarine from anthracene, and not to work out all the possible reactions for its production.

That at the time of their invention the claim in it was thought by competent men to be the production of alizarine from anthracene by

any method, can be seen from the following quotations. Prof. Wagner, editor of the "Jahresbericht fuer technische Chemie," after giving an abstract of Græbe and Liebermann's English patent, says: "The patent covers not only the above described process but also the idea of the production of alizarine from anthracene." Jahresbericht 1869, p. 601.

It has been said that the inventors had to give up their original patent, because they were unable to prove that their process had been in practical operation. In regard to this matter it will be of interest to hear the authentic history of the early state of this invention as given by Professor Liebermann in a letter, dated Berlin, Dec. 21st, 1875, and addressed to the Badische Anilin and Soda Fabrik, Ludwigshafen, and which is annexed to the affidavit of Adolf Kuttroff in this suit, sworn to May 13, 1878.

I have seen this letter, and being familiar with Prof. Liebermann's handwriting believe it to be written by himself. He says therein (translated):

"BERLIN, *December* 21*st*, 1875.

Badische Anilin and Soda Fabrik, at Ludwigshafen.

That Græbe and Liebermann, the inventors of the artificial alizarine production, were not by any means compelled to surrender their Prussian patent, as Reimann maintains, 'because they were unable to prove that their process could be practically carried out,' you, who have practised it for some time, know best yourselves. The following are the real facts of the case, as appears from the official correspondence had with the patent office. Our application of August 27th, 1869, for a patent for the sulfo-acid process (as an improvement on the previously-granted patent), was rejected on the ground that the second process was held to be too similar to the first to admit of the granting of a patent. Our reply, that then necessarily the second process must be protected by the first patent, was answered by the ministry, on November 23d, to the effect that this was not the case, because the details were not the same, and because for the practical application in particular the modifications were important. When we called attention to the contradictions in the two decisions, after protracted pressure a re-examination of the matter was had, but then (May 13, 1870,) an adverse decision given, because (owing to our English patents which meanwhile had, of course, been published,) the process was already published. Any one was then at liberty to use the sulfo-acid process, consequently we had no inducement for doing anything towards sustaining the bromine patent. For this reason we abandoned the Prussian patent, which was then revoked July 7th, 1870.

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Respectfully yours,

(Signed) C. LIEBERMANN.

It has been contended that Graebe and Liebermann's patent only covers the chemically pure substance alizarin of the formula $C_{14} H_8$

O_4 and their own words have been cited in proof thereof. In relation to this, it must be kept in mind that the word alizarin is used in two senses: 1st, as meaning the chemically pure substance, and 2nd, as meaning different preparations, used as dyestuffs. As an illustration, I would cite the use of the word cane-sugar. While, in a chemical sense, it means a substance of a certain uniform composition, with well-defined chemical and physical properties, the same term is applied to commercial products of a very different and changing composition. Now, it is known that the chemically pure body cane-sugar consists only of carbon and the elements of water. If I succeeded in combining these, by the use of some reagents to produce cane-sugar, I would, for the sake of proving the fact to other chemists, have to separate the chemically pure body and to compare its properties with the known properties of chemically pure cane-sugar. If only a small part of my product actually consisted of chemically pure cane-sugar, and if the quantity isolated was ever so small, I would have the right to claim that I was the first to produce cane-sugar artificially from carbon and water. Finding further that the raw product of my process, from which I isolated the chemically pure cane-sugar, contained, besides cane-sugar, various other compounds of a sweet taste, but different from cane-sugar, and could be used as other kinds of commercial sugars are used, and was perfectly free from substances injurious to health, I having succeeded to remove all the chemicals, which were used in its preparation, I would probably try to obtain a patent for this product, call it artificial cane-sugar, and recommend it for general use by saying that it is perfectly pure and a fit substitute for ordinary cane-sugar.

This is essentially the course Graebe and Liebermann took with regard to their invention. When they first communicated their discovery to the German Chemical Society (Berichte der Deutschen Chem. Gesellschaft II, 14,) they submitted samples, not of the raw product, consisting of yellow flocks, but of a sublimed substance and of swatches dyed with the latter. In their second publication, (Ber. II, 334,) when they speak of the identity of artificial and natural alizarine, they refer expressly to their first note. On the other hand, in their patent they do not even mention the sublimed substances, but only speak of the "yellow flocks," the raw product. If, in this connection, they call the product pure, it can only mean that for practical uses it need not be any further purified, as it does not contain any substances injurious in the dyeing process. And further, having described, in their patent, the use of sulphuric and nitric acids, bromine and caustic potash or soda, some of the most destructive agents which are known, it is probable that, by calling their product pure, they wished to more strongly impress on the mind of those without special chemical knowledge the fact that none of those dangerous substances was left in it.

Whether this is so or not, absurd it would have been for Graebe and Liebermann to assume that their final product, as described in the patent, was anything like a chemically pure substance. It is and

fully was known at that time that, in all process of organic synthesis, so-called secondary reactions take place, by which the yield of the substance, for the production of which the principal reaction was undertaken, is seriously impaired. Chemists in general are satisfied, if in difficult reactions they get 50 per cent. of the possible or theoretical yield, as indicated by the chemical equation. If it comes any way near this theoretical value, it is mostly expressly stated. Chemical equations are symbols, giving in precise and short language to a chemist the description of some particular reaction. They represent the entire actual results only in the imaginary case that no secondary reactions take place. The products of such so-called secondary reactions therefore are always in greater or less quantity present in the final raw products, and a subsequent treatment of the final raw product is necessary, in order to obtain any one of the different products separate from the others. No such subsequent treatment or separation, by sublimation *other* otherwise, is referred to in Graebe and Liebermann's patent, nor do they mention in their patent any sublimed or isolated substance separated from their final raw product, the yellow flocks, by any subsequent treatment.

The product of Graebe and Libermann's process was as a matter of course a complex substance, and it is a perfectly fair supposition that they knew it. They did not know the exact nature and composition of all the substances constituting the product, and could not give the chemical equations representing the so-called secondary reactions by which they were formed. Later, a great number of such substances were
236 isolated from the raw product, and their formation explained by equations. Among these I will only mention, as having been most completely investigated, oxyanthraquinon, ahthraflavic acid, anthrapurpurin. It has been objected that the artificial alizarine or final raw product, yellow flocks, from which the last-named substance was first isolated, was produced according to that modification of Graebe and Liebermann's process which substitutes sulphuric acid for bromine, and that it was doubtful if it was produced in the first described or shortly called bromine process. In this connection the following extract of an original letter of Prof. Liebermann will be decisive. This is dated Nov. 16, 1875, and addressed to the "Badische Anilin and Soda Fabrik, Ludwigshafen," and is annexed to said affidavit of Mr. Kuttroff; I recognize it as being in Mr. Liebermann's handwriting.

It says (translated): "By the fusion of bibromanthraquinon (from anthrachinone) and potassa, anthra- or isopurpurine are certainly formed, although not in exactly considerable quantities. To prove it, I follow the directions of Perkin for anthrapurpurine. The coloring matter resulting from the fusion, and which has been precipitated and washed, is treated with a solution of soda and shaken with freshly precipitated (and washed) hydrate of alumina. On filtering, the purpurine goes into solution; what was in solution was again precipitated and treated in the same manner, and this repeated several times. After thus treating it three times, its quantity was con-

siderably lessened, but there was still isopurpurine present. That the coloring matter obtained from bibromanthraquinone contains isopurpurine is also shown by the enclosed swatches dyed with the (thoroughly washed) raw product."

I have read the statement of Mr. G. Auerbach, presented in this case; whenever he speaks of isopurpurine in comparison with purpurin from madder, he lays particular stress on the fact that both substances have the same chemical formula and are isomeric. This way of putting it is very apt to create a wrong impression in the mind of anybody who is not sufficiently familiar with chemical terms, because it seems to imply that these bodies are next to, if not altogether identical. While, on the contrary, a chemist describing two substances as isomeric wishes by that word to express the idea that they are not identical but different in their properties, though having the same chemical formula. In fact, isomeric substances will often differ more in their properties than substances of different formulas, but otherwise related, do.

In the passage of Mr. Auerbach's affidavit which reads as follows: "Finally, I recapitulate again, that purpurin made from madder (in practical use and the strict chemical use of the expression) is altogether identical with the purpurine made from anthracene," etc.—if the words "purpurine made from anthracene" refer to a substance of the formula $C_{14}H_8O_5$, produced by Graebe and Liebermann's process, either the bromine or the sulpho-acid modification—then this statement is simply untrue, and the authorities quoted do not confirm it.

237 As Mr. Auerbach further chooses to bring his "direct" and, as he thinks, "irrefutable authority" to bear in this case instead of facts, I think it proper to give in this connection my opinion in regard to this authority. To the best of my knowledge and belief his authority, in regard to the purely scientific part of the question, is not of such a high standing among chemists in general as he evidently believes. His published scientific investigations, in regard to artificial alizarine and isopurpurine, lack thoroughness and read more like occasional notes; even about isopurpurine, for the discovery of which he gives himself particular credit, we know very little from the description he gives, he having neglected to investigate either its chemical combinations or its behaviour as a dye-stuff. On the other hand Perkin, after publishing a preliminary note in 1870, and his analysis and formula in June, 1872, gave in 1873 a full, definite, and exhaustive treatise on his anthrapurpurine, accompanied by specimens illustrating its dyeing effects. Nothing in these publications proves that anthra- and isopurpurine are identical, and no chemical investigation to prove this identity has been published since. But if they were really one and the same substance, then Mr. Auerbach would not be the discoverer, but Mr. Perkin, whose communication, in which he for the first time stated the presence of a substance of the formula $C_{14}H_8O_5$ in artificial alizarine, was made to the London Chemical Society on the 6th of June, 1872, two

months before Auerbach made any reference to isopurpurine. In relation to madder dye-stuffs, Auerbach has not published any original researches at all. If he founds his claim of "irrefutable authority" on the fact that he has published a pamphlet on anthracene, it must be understood that this is a compilation involving, as is natural with the subject, a good deal of work, but none original. The title of the first edition is: "Anthracene and its derivatives, for the arts and science, compiled from the known authorities." The English edition, which is translated and edited by W. Crookes, is only enlarged, containing the latest publications, but the plan of the work is not essentially altered.

ARNO BEHR.

Subscribed and sworn to before me this 13th day of May, 1878, at Jersey City.

[L. S.] J. VAN WEORT,
Notary Public.

238 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABKIK
vs.
T. K. CUMMINS.

CITY OF BOSTON, DISTRICT OF MASSACHUSETTS, *ss.*

JOHN M. ORDWAY, being duly sworn, deposes and says:

I reside in Boston, in the state of Massachusetts, and am professor of industrial chemistry and metallurgy in the Massachusetts Institute of Technology. I have been engaged for a large part of my life in the manufacture of chemicals, and was formerly superintendent of the Manchester Print Works, in Manchester, New Hampshire. I have read the deposition of William Bogle, entitled in the above suit, dated the 20th day of April, 1878; that of James Threlfall, dated the 20th day of April, 1878; that of Albert Horton, dated the 19th day of April, 1878; that of John Bracewell, dated the 18th day of April, 1878; that of Robert Henry, dated April 17, 1878; that of Henry Burrows, dated the 18th day of April, 1878; that of Thomas Walsh, dated the 15th day of April, 1878; that of James Hunter, dated the 17th day of April, 1878; and I concur in the general statements contained in all these depositions except so far as they maintain the equal fastness of the madder and the artificial alizarine colors, and except as to the statement that madder dyestuffs and artificial alizarine can be substituted for each other with equal and equally good results. Mr. Bracewell says (p. 16 of the printed record): "Colors made from the use of artificial alizarine are no more fast than those obtained by madder" Mr. Henry says (p. 17 of the record), "the colors dyed with artificial alizarine are not more fast than those dyed with madder." Mr. Burrows says (p. 19 of the record), "artificial alizarine colors are no more fast than those pro-

duced by madder." Mr. Walsh says (p. 22 of the record), "colors produced by the use of artificial alizarine are no more fast than those produced by madder." Mr. Hunter says (p. 23 of the record), "the colors are equally fast, whether they are produced by madder preparations or artificial alizarine."

These gentlemen have, one and all, carefully avoided making the only statement which could give value to such testimony, viz: that they have actually made exact comparative trials, and therefore personally know whereof they affirm. Indeed three of them prejudge the matter by giving us to understand that such trials are en-
239 tirely unnecessary. Mr. Bracewell says (p. 16 of the record), "as madder colors are perfectly fast, and nothing can be more permanent than they are." Mr. Burrows says (p. 20 of the record), "colors produced from madder are absolutely fast, and no colors can be more permanent than they are." Mr. Walsh says (p. 22 of the record), "the colors produced by madder are absolutely fast, and nothing can be more permanent than they are."

In appending their signatures to statements showing such a remarkable verbal coincidence, these three gentlemen must have understood the term "fast" in its loose commercial sense. They certainly are well aware that, though the madder colors have the reputation of being pre-eminently fast, these colors differ much among themselves in the degree of fastness, and that all of them are, in this respect, far inferior to aniline black. Mr. Bogle has more justly said (pp. 6 and 7 of the printed record), "different brands of garancine, made from French madder, differ from each other in the tints which they produce and in the fastness of the coloring." "When the goods printed with the extract are 'soaped,' the 'soaping' takes out the coloring from the figures." And "Turkey madder will not give good pink colors, but will make a faster purple than the French madder, while French madder will make a much better and faster pink than Turkey madder can."

It is well known among calico printers that goods dyed with garancine will by no means endure the severe treatment to which madder-dyed Turkey-red and madder pinks are always subjected. It seems to me, therefore, that Messrs. Bracewell, Burrows, and Walsh, in their over-zealous defence of madder colors, have been betrayed into language much more positive than the real facts warrant. These gentlemen may have gone so far as to satisfy themselves that the artificial alizarine colors are *as* fast as the average of the much-prized madder colors, and that is all the printer commonly cares about. Had they gone farther and actually made comparative tests as to whether the artificial alizarine colors are any *more* fast than the average madder colors, they certainly would have been more guarded in their statements.

A marked difference in fastness is brought out by the method which I have used, and of which some of the results have been exhibited in the case of Badische Anilin and Soda Fabrik *vs.* Hamilton Manufacturing Co. This method was devised by Wagner in 1875,

and published by Brandt in the Bulletin de la Société Industrielle de Mulhouse for February and March, 1876. In corroboration of my own results, I here translate the following extracts from p. 124 of the above work. Wagner says: "Having found that a mixture of soda and ferricyanide of potassium greatly degrades the reds of madder extract, and has almost no effect on those of artificial alizarine," etc. "I have, however, profited by the favor of M. Tatarinof, who was kindly willing to repeat my trials, and has arrived at the same results as myself." On page 125 Brandt says: "I have repeated these trials with the collaboration of M. Dupuy, and we have proved the exactness of all the data of M. Wagner." On page 126 Brandt gives us:

240 "1. *The effect on colors not brightened*, (i. e., not soaped,)—

"Artificial alizarine—red slightly attacked; the iron mordants do not resist so well as the alumina mordants.

"Garacine—all the tints strongly attacked; the rose and the light purple almost completely decolorized.

"Meissonier's extract of madder—effect almost the same as with garancine.

"2. *Effect on brightened colors*—

"Artificial alizarine for red—no attack.

"Meissonier's extract of madder—strongly attacked."

Thus we have the concurrent testimony of four competent, disinterested experimenters that artificial alizarine gives colors decidedly more fast than those of garancine or extract of madder. And I have found the same thing true with three different skecimens of artificial alizarine in comparison with Meissonier's madder extract and garancine of an excellent brand. For convenience of reference I append duplicates of the swatches exhibited by me in the case above cited.

II.

I have read the affidavit of Charles F. Chandler, made the 24th day of April, 1878.

Prof. Chandler, after saying (p. 26 of the record) that Græbe & Liebermann invented a process for producing alizarine out of anthracene, goes on to imply that the invention amounted to very little, for Laurent had devised one necessary step and the other step consisted in the use of well known processes.

We all know that it was no great affair for Columbus to discover America. He had only to sail westward. Mankind had before learned the use of the compass, and knew how to provision ships for long voyages. They had even made longer voyages than the one in which the old enthusiast discovered the insignificant island which was not India after all.

If I understand the general sentiment of the scientific world, it is unreservedly admitted that Græbe and Liebermann were the first to show chemists that they had been looking in the wrong direction for the much-desired synthesis of alizarine. They showed its true chem-

ical relations by breaking it up and then reconstructing it from material known to exist in coal tar. That material was not in the market, and easy methods for its isolation and purification were not yet known. That the process was not immediately carried out on a large scale was surely due in some measure to the fact that a ready supply of anthracene had yet to be provided. With the present facilities for procuring any amount of the necessary materials it would be perfectly practicable now to manufacture artificial alizarine by the process as originally described. But that modification of the process wherein the monovalent sulphurous acid group is substituted for the bromine atom is still the most economical notwithstanding the reduced price of bromine. I see no reason for Prof. Chandler's assertion that the sulpho-acid process is not a simple equiv-
241 alent for the bromine process. The chemical reactions involved are essentially the same and the results are the same. It is similar to the substitution of ammonia for soda in a chemical operation. If Græbe and Liebermann attempted to carry out the acid process and did not at first succeed, this shows that theoretical reasoning had led them to suppose such a process possible, the principle involved in it being just the same as in the first successful plan. If the sulpho-acid process proved available after they had associated Caro with themselves, it was still theirs. Græbe and Lieberman made alizarine from anthracene by the use of no new chemical principles, but they showed that alizarine could be made from anthracene, and they devised an ingenious combination of principles or a succession of steps by which the change could be effected. They are entitled to the discovery of the fact, and they are entitled to the combination of the necessary steps whether the precise detail of each single step or even the order of the steps is preserved or not.

After quoting Græbe & Liebermann's exhibit of the reactions by which alizarine forms from anthracene, Professor Chandler goes on to say (p. 29 of the record): "There is nothing in the formulas given by Græbe and Liebermann that will indicate to a chemist or lead him to suspect the simultaneous formation of any other compound than alizarine." Most chemists have sense enough to take it as a matter of course that secondary products will be made in the artificial formation of organic substances. A perfectly clear reaction is a rarity in organic chemistry, and is only when such a one is found that chemists usually think it worth while to make a note of it as something uncommon. The books give us equations showing how a molecule of rosaniline is formed from one molecule of aniline and two of tolnidine by an oxidation which removes six atoms of hydrogen, and they do not attempt to exhibit any of the secondary reactions, though it is well known that not one-half of the material becomes rosaniline, the rest going to form violaniline, mauvaniline, resinous matter, and nobody knows what else. So also sugar is represented as breaking up by fermentation into carbonic acid and alcohol, $C_6H_{12}O_6=2CO_2+2C_2H_6O$. Yet we are told that glycerine, succinic acid, and cellulose are always formed out of the sugar when it

ferments. Therefore, as Græbe and Liebermann have not distinctly said that the reaction formulated by them is a clear one, the experienced chemist would naturally suppose that secondary products are formed simultaneously with alizarine.

Professor Chandler admits (p. 30 of the record) that what was named by Perkin, in 1873, anthrapurpurine had been observed by Perkin in 1870 and described and analyzed in 1872, and yet he credits the discovery of anthrapurpurine to Auerbach, who published an account of his isopurpurine in August, 1872, two months after Perkin had described to the Chemical Society of London the substance which Professor Chandler calls identical with isopurpurine, the analysis and formula being included in Perkin's description. Scientific men generally do not admit any man's claim to discovery unless he was the first to publish an account of the substance in question.

242 Some of Professor Chandler's statements respecting the relations between purpurine and anthrapurpurine are rather loose and inconsistent. He says (p. 30 of the record): "These differences and other peculiarities, which have no relation to its practical value or effect, shows that it is isomeric with purpurine." Differences and peculiarities, which do have relation to its practical value, show a lack of identity, but how any differences and peculiarities can show isomerism, I am at a loss to understand. It is generally supposed that isomerism can be ascertained only by analysis.

He says on the next page that the differences between purpurine and anthrapurpurine are very slight; and yet in the next paragraph we are told that anthrapurpurine is more valuable than purpurine, because of its greater fastness. Again, when Professor Chandler speaks of "shades of color" he appears to mean *hues* or *colors* instead of depths of color. He appears also—like the calico-printers in the preceding affidavits—to have considered the production of the same hues or "effects" to be the same thing as the production of colors equally good and desirable. It is possible to obtain with logwood, hypernic wood, and the like, the same hues or effects as with madder, but the colors so made will be comparatively worthless for want of permanence. The proper question to be settled with respect to colors is not whether the shades and the hues are the same, but whether they will bear exactly the same tests with destructive agents.

Professor Chandler says (p. 32 of the record) that Græbe and Liebermann's patent "is explicit and precise in describing a perfectly intelligible process for producing a well-known substance called alizarine, and in my judgment no chemist who reads that specification can find any evidence in it that it is there proposed to produce anything by that process but perfectly pure alizarine."

There is certainly room for other judgments besides that of Professor Chandler. It has been shown in the case of Badische Anilin und Soda Fabrik *vs.* Hamilton Manufacturing Company, as well as in the present case, that the word "alizarine" has been used in many senses, and that it does not necessarily convey the idea of absolutely

pure alizarine. In Græbe and Liebermann's United States patent, dated April 4, 1871—the only patent which is specially to be considered in the present suit—there is no mention of pure alizarine, nor is any method specified for the further purification of "the yellow flocks" of alizarine. They simply propose to get "*the* alizarine in a form in which it can be employed in the same manner as the different preparations of madder. We are not directed to dry the substance or to sublime it, and it would be difficult to insure absolute purity without drying and subliming. They claim not absolutely pure alizarine, or even pure alizarine. They say nothing about the identity or the isomerism of their alizarine with madder alizarine, but claim a new "artificial alizarine produced from anthracene or its derivatives by either of the methods herein described, etc." And no chemist conversant with the manufacture of similar products would, for a moment, suppose that either of "the methods herein de-
243 scribed" would give an alizarine free from secondary products.

It goes without saying that all we can reasonably ask of the inventors is to describe a process by which we can produce alizarine sufficiently pure to be used as a dyeing material, and as good as the ordinary preparations from madder. That the inventors did not, in this patent, contemplate absolutely pure alizarine is plain, in my judgment, from the fact that they say nothing about purity, although they had previously, in the preliminary specification for the English patent, spoken of the yellow flocks as alizarine "perfectly pure." That they used the expression "perfectly pure" in the preliminary specification, and afterwards modified it, and finally dropped all allusion to purity in the American specification, in my judgment proves exactly the contrary to what Professor Chandler tries to make out. It shows that they found reason to suppose that the expression "perfectly pure" was too strong and too liable to misinterpretation. Whatever might have been their idea in the first flush of discovery, it is evident that, in their matured application for a United States patent, they had no intention of claiming to make chemically pure alizarine. No doubt the original object and aim of their invention was to make alizarine, and before alizarine was made from anthracene the valuable isomers of purpurine were still unknown bodies. It had been supposed by many that alizarine was the only valuable or important color of madder; in fact, the true and exact characters and mutual relations of the colors producible from madder were not known till Rosenstiehl's investigations were made, long after the discovery of artificial alizarine.

Thus, in a paper read by Rosenstiehl, before the Industrial Society of Mulhouse, occur the following true remarks which I translate from the Bulletin Soc. Ind. de Mulhouse for November, 1874, p. 539:

"At the time of which I am speaking [1864] they had disregarded the part of purpurine in madder dyeing. Alizarine, before its synthesis, had never been obtained in the state of purity, that is to say, totally free from purpurine. They attributed the special tint of

madder-dyed red to alizarine alone, and purpurine was considered as useless or of secondary importance."

On p. 540 he says: "After having fixed the true molecular weight of alizarine, and its constitution, which is that of a bioxyanthraquinone, Messrs. Græbe and Liebermann expressed the opinion that purpurine, containing an atom of oxygen more, must be trioxyanthraquinone; they ought to be able to transform alizarine into purpurine, by introducing, by substitution, the group HO in place of an atom of H of alizarine."

Before 1868 alizarine had been the object of Roussin's investigations in working with naphthylamine, but the result was not really what was sought for. Roussin did obtain an alizarine,—I use the term here in its generic sense,—bearing the same relation to naphthaline that ordinary alizarine does to anthracene, and Roussin could have claimed a monopoly of the manufacture of naphthaline alizarine, or naphthazarine, or by whatever name he chose to call it; but he could only claim what his process made. Græbe and
244 Liebermann's result, whatever they supposed it to be at the time, was not unmixed alizarine. They could only claim what they actually got, or what others would actually get by the process proposed, or by equivalent processes, and not what they proposed to get. The specification of the patent has nothing whatever to do with the Vienna report. In the report they have simply pointed out the main and best understood reaction, and have wisely refrained from attempting to account for the numerous secondary products. In the specification they give us no theoretical reasoning and no formulas. They merely describe certain processes, and name the product alizarine. They are entitled to each and all of the products of the final reactions when made by these or similar means and from the same material. It matters not whether they fully understood all the reactions or not. It matters not whether or not they named the products correctly, or left them unnamed. Chemically pure alizarine had been before very little known, and was certainly of no practical importance. They succeeded in producing, artificially, a dyestuff capable of replacing madder. But they did more than they intended, and the world is the gainer by their having actually made coloring matters which together are superior to those contained in madder. The world can afford to give them credit for all that they actually did.

III.

I have read the deposition of G. Auerbach in the above suit, dated the 25th day of March, 1878, in which deposition said Auerbach claims to be an authority on "the management of alizarine from madder and the manufactnsing of alizarine from anthracene." In the same deposition Mr. Auerbach brings his assumed "authority direct and irrefutable" to discredit, crush, and annihilate the "assertions of Professor Morton and other gentlemen in America."

Unfortunately he has adduced, throughout his affidavit, hardly anything but his own authority.

The world is indebted to Auerbach for an excellent compilation entitled "Das Anthracen," G. Auerbach, Berlin, 1873; of which a translation into English, with additions, was published by W. Crookes in 1877.

Being acquainted with these books and other publications of the author, "Professor Morton and the other gentlemen in America," though much pleased with the general merits of the books, feel hardly willing to admit their full reliability or the absolute authority of the compiler, and would prefer to reserve the right of appeal to a higher tribunal.

In speaking of isopurpurine, on page 203 of the English translation, the author says:

"This isomer of purpurine was discovered by Auerbach in a product manufactured by Gessert Brothers, under the name of 'artificial purpurine,' and subsequently described by Perkin as anthrapurpurine. Perkin's anthrapurpurine was said to be distinguished from Auerbach's isopurpurine by its insolubility in alcohol, and by the sparing solubility of its soda-salt in the same solvent. Subsequent researches, however, have proved the identity of both compounds."

245 Now, according to the usage of the scientific world a claim of discovery is invalid unless sustained by priority of publication. Perkin gave notice before the Chemical Society of London, November 2, 1871, that he was engaged in the investigation of a by-product in artificial alizarine. At a subsequent meeting of the society held June 6, 1872, Perkin read a paper giving an account of the properties and composition of the new substance, which, in a subsequent more extended paper, published in 1873, (Journal Chemical Society, xi, 425,) he named anthrapurpurine. An abstract of the proceedings of each of these meetings was published in the Chemical News of the following week. (Chemical News, xxiv, p. 226, and xxv, 284.)

So a sufficiently full account of the new substance had been published to the world two months before Auerbach gave, in the Moniteur Scietifique of August, 1872, his description of isopurpurine as an isomer of purpurine.

If anthrapurpurine and isopurpurine are identical as well as isomeric, Auerbach was not the discoverer. If Auerbach's assertion as to identity is not true he was the discoverer of isopurpurine, while Perkin had been the discoverer of the isomer anthrapurpurine. A comparison of dates shows how much fairness there is in Auerbach's statement that "it was subsequently described by Perkin as anthrapurpurine."

It is remarkable that Auerbach, under the head of bibliography, in the English translation of his work, should have referred to every paper or notice in the Chemical News up to 1875, bearing on anthracene and its derivatives except the one in vol. XXIV, p. 226,

and that in vol. XXV, p. 284, the very ones that show Perkin to have been the discoverer of anthrapurpurine.

I have been unable to find in any later publications accounts of accurate comparative tests which "have proved distinctly the complete identity of these two preparations." Schunck and Rœmer certainly do not seem to me to give any positive proofs of this identity; they did actually find a difference which they *supposed* was due to some impurity in Perkin's own specimen, but they did not establish the real existence of such impurity.

Mr. Auerbach's assertion (p. 35 of the record) that Prof. Morton pretends that isopurpurine and anthrapurpurine are not isomeric with purpurine from madder, is utterly at variance with my understanding of Prof. Morton's testimony in the case cited. Auerbach here, as in some other instances, seems to have confounded isomerism with identity. He certainly fails to append suitable qualifications to his statement, (p. 38 of the record,) that "purpurine made from madder" "*is altogether identical with the purpurine made from anthracene.*" Whether there can or cannot be made from anthracene purpurine altogether identical with the madder purpurine matters not. Certainly madder purpurine is not identical with each and all the anthracene purpurines.

I believe there has not been brought forward as an exhibit in this case any specimen of "chemically pure alizarine so gained from the monoxanthraquinon sulfo acid, perfectly identical with the alizarine from madder," nor any sample of "purpurine made from anthracene" which is "altogether identical" with "the purpurine
246 made from madder." In fact, no specimen has been exhibited of articial alizarine that does not contain the isomeric anthracene purpurines which are so useful in assimilating the colors of artificial alizarine to those of madder and garancine. I do not understand that the plaintiffs in the present suit have raised any question respecting purpurine identical with madder purpurine. None such has been shown to exist in the specimens of artificial alizarine sold by either of the parties to the suit.

IV.

I have read the deposition signed by Carl Otto Neuhaus, the 6th day of April, 1878, and by Carl Rumpff, the 5th day of April. They say (pp. 40, 43 of the record): "It is entirely under my control when I make alizarine, whether I obtain an alizarine perfectly pure, etc.;" and again, "I have regularly made and am making now this alizarine identical with pure alizarine from madder, which is largely used for making pinks and fine purples, and which is perfectly free from such impurities."

These gentlemen must refer to what is known in the market as "alizarine for violet," and by "perfectly pure" and "perfectly free" they doubtless mean "pure" and "free" in the ordinary commercial sense. Chemists are not usually willing to consider the manufacturer's mere assertion as a sufficient guaranty of the real purity of a

chemical product, or of its entire freedom from substances which are usually found in similar products. They wish to know what tests have been applied, and would prefer to have the testing done by a disinterested party. The criteria of the maker may possibly not be *experimenta crucis*. Thus, another alizarine manufacturer, G. Auerbach, attempts to make out (p. 38 of the printed record) that Prof. Morton could not tell, by chemical tests, madder-dyed reds from artificial alizarine reds, because the purpurine in madder gives the same tints as anthrapurpurine. Auerbach, therefore, appears to rely himself on the very uncertain color test alone, and to suppose that others are no wiser than himself in this matter.

Messrs. Neuhaus and Rumpff do not deign to assign any reasons whatever for their positive assertions as to the purity of their manufactures. Scientific chemists generally deem it proper and courteous to be more specific as to the grounds of their statements. Thus M. Lalande, in giving an account of the synthesis of purpurine out of artificial alizarine, in the Bulletin de la Société Industrielle de Mulhouse for Nov., 1874, p. 535, says, in words which I here translate: "The characters of the body leave no doubt as to its identity with natural purpurine;" and then goes on to add, "the same coloration by alkalies, solubility in the same reagents, the pink color and fluorescence of the alum solution, the same tints imparted to mordanted tissues, and the same solidity of these tints, etc."

Careful, trustworthy chemists do not claim the same absolute control of natural forces as do Messrs. Neuhaus, Rumpff and Auerbach, and they find it difficult to secure absolute purity. Thus Rosenstiehl, in Mulhouse Bulletin for Nov., 1874, p. 545, says, in words which I here translate: "Alizarine prepared by the processes described in the books is not pure. After sublimation it is necessary to make it crystallize a great number of times, till a dyeing test demonstrates the complete identity of two consecutive mother liquors. In operating on an artificial alizarine for violet (such as No. 1 of Meister Lucius), we arrive quickly at a good result." It would seem by this that Rosenstiehl found something more than pure alizarine in the best commercial product.

247 Again, we may judge somewhat of the lack of clearness and perfection in these chemical transformations from the yield which Rosenstiehl obtained. On p. 546 of the work above cited, he says: "To transform the alizarine according to the process of M. Lalande we have dissolved 50 grams of artificial alizarine, etc." "The yield was 10 grams=20 per cent."

Lalande did not mention the percentage which he obtained, but hoped to arrive at better results after a fuller study of the proper conditions. I have been unable, however, to find any later accounts showing that his hopes had been realized.

Messrs. Neuhaus and Rumpff declare that they have not found in their five years' experience as alizarine makers (pp. 41 and 43 of the printed record) that the temperature or the quantity of alkali has any effect on the quantity of bodies which dye yellowish red. It may be

proper to quote the statements of one who has had more than five years' experience, and has studied the matter from a scientific as well as practical point of view. W. H. Perkin, in a paper read before the British Association for the Advancement of Science, 6th September, 1876, as reported in Dingler's Polytechnisches Journal, CCXXIII., p. 321, stated that every artificial alizarine contains more or less anthrapurpurine. He "attributes to this presence of anthrapurpurine in alizarine a very prominent part in alizarine dyeing, in respect to the fastness as well as the liveliness of the resulting tints. Anthrapurpurine is, according to him, as valuable a color as alizarine itself. It is far superior, as a dyeing material, to its isomer purpurine, which has little importance as a dyestuff." "To explain mode of origin of anthrapurpurine in the production on a large scale, Perkin mentions the fact that the starting point for alizarine is not pure anthraquinon-di-sulphuric acid, but a mixture of this with anthraquinon-mono-sulphuric acid. Now, the latter $C_{14}H_7(SO_3H)O_2$, by heating with caustic potash or soda gives first monoxyanthraquinone $C_{14}H_7(HO)O_2$, a yellow substance without value for dyeing; by farther fusion with hydrate of potash this oxidizes to dioxyanthraquinone or alizarine $C_{14}H_6(HO)_2O_2$. Anthraquinone-di-sulphuric acid $C_1H_6(SO_3H)_2O_2$, gives, by heating with alkalies, first the salt of an oxyanthrachinon-sulfo-acid of the composition $C_{14}H_6(HO)(SO_3H)O_2$, since at first only one sulphuric acid residue is exchanged for hydroxyl; out of this intermediate member arises by a farther heating a dyoxyanthraquinone $C_{14}H_6(HO)_2O_2$, anthraflavic acid, an isomer of alizarine without its dyeing power; and out of anthraflavic acid there is formed again, by farther continued melting with potash hydrate, as an oxidation product, an actual coloring matter, anthrapurpurine, of the composition $C_{14}H_5(HO)_3O_2$."

248 "But in the melt there is evolved, at the same time, hydrogen, which operates a partial reduction of both oxanthraquinones."

It is evident, then, that whatever may be done with absolutely pure anthraquinone-mono-sulphuric acid, as Græbe and Liebermann used material containing a large proportion of the *di* and not much of the *mono* compounds, they could not but get anthrapurpurine as well as alizarine, and that it played an important part in the artificial alizarine made by them and others. If any other material intermediate between anthracene and alizarine is more suitable for producing a greater proportion of true alizarine, it matters not.

JOHN M. ORDWAY.

Subscribed and sworn to before me this 13th day of May, 1878.

JOHN G. STETSON,
U. S. Com'r.

United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In Equity.

UNITED STATES OF AMERICA, SOUTHERN DISTRICT OF NEW YORK, *ss.*

ADOLPH KUTTROFF, being duly sworn, deposes and says that he made an affidavit in this suit March 6th, 1878; that annexed hereto is a letter from C. Liebermann, in German, to the complainants, dated December 21, 1875, a translation of which is also annexed; that also annexed hereto is another letter, in German, from said Liebermann to the complainants, dated November 16, 1875, a translation of which is also annexed; that both said letters were sent to deponent's firm by complainants; that deponent is familiar with the German language, and that he has examined the said translations, and that the same are correct translations of said letters.

Deponent further says that he knows James Hunter, whose affidavit, dated April 17, 1878, is produced by defendant; that in February, 1873, the said Hunter gave to deponent at said Hunter's Print Works, in Philadelphia, two swatches, telling deponent that one was printed with madder extract and the other with artificial
249 alizarine of complainants; that annexed hereto are pieces of said two swatches, the one marked "Madder Extract" being that which said Hunter said was printed with madder extract, and the piece marked "Artificial Alizarine" being that which said Hunter said had been printed with artificial alizarine; that said Hunter told deponent at the time that the red produced by artificial alizarine was different from the red produced by madder extract and preferable for many patterns; whereupon, and as deponent understood from the results of these and other tests, the Messrs. Hunter contracted with deponent's firm for the delivery to them of one hundred barrels, being about 40,000 pounds, of artificial alizarine.

ADOLPH KUTTROFF.

Subscribed and sworn to before me this 13th day of May, 1878.

[L. S.] W. HAUFF, (10,)
Notary Public N. Y. Co.

(2 Swatches.)

Berlin, 16. 11. 75.

Badische Anilin und Sodafabrik in Ludwigshafen.

Beim Verschmelzen des Dibromanthrachinons (aus Anthrachinon und Kali) bilden sich allerdings, wenn auch nicht gerade beträchtliche Mengen Anthra, oder Isopurpurin. Zum Nachweis verfuhr ich nach den Angaben Perkin's für Anthrapurpurin; der aus der Schmelze wie gewöhnlich gefällte und ausgewaschene Farbstoff wird in Sodalösung aufgenommen und mit frisch gefälltem (u. ausgewaschenem) Thonerdehydrat geschüttelt. Beim Filtriren geht das Purpurin in Lösung; das in der Lösung befindliche wurde wieder

gefällt und ebenso behandelt, und so mehrmals. Nach dreimaliger Behandlung hatte sich die Menge zwar bedeutend vermindert, es war aber noch Iso-Purpurin vorhanden. Daß der aus Bibromanthrachinon dargestellte Farbstoff Isopurpurinhaltig ist, zeigt wohl auch die Färbeprobe des (übrigens vollständig ausgewaschenen) Rohprodukts (Liegt bei). Einen vortrefflicheren chemischen Beistand für Amerika können Sie gar nicht bekommen als den Dr. Arno Behr, welcher längere Zeit mein Assistent war und sich gerade in Amerika aufhält. Er ist den Herren Caro und Glaser sicher wenn nicht persönlich so durch seine wissenschaftlichen Arbeiten bekannt; er ist ein ausgezeichnet fähiger und williger, fleißiger Mann, der die Alizarinarbeiten genau kennt. Obwohl er augenblicklich sich in einer Fabrik befindet, würde er vielleicht den Auftrag als Experte zu fungiren, schon aus Anhänglichkeit für mich, übernehmen. Er würde Ihnen jedenfalls keine große Kosten verursachen, vielleicht als wirklicher chemischer Sachverständiger manchen unnützen Expertenversuch ersparen. Ich theile Ihnen deßhalb zu Ihrem event. Gebrauch seine Adresse mit.

Dr. Arno Behr,
Care of Messrs. Matthiesen & Wiechers,
Sugar Refining Co.,
Washington street,
Jersey City, (N. J.)

Das Anthracen ist angekommen und habe ich die Anstellung einiger Versuche in Aussicht genommen.

Hochachtungsvoll

Liebermann.

(Swatches.)

250 (Translation.)

BERLIN, 16, 11, 75.

Badische Anilin and Sodafabrik at Ludwigshafen.

By the fusion of bibromanthrachinon (from anthraquinon) and potassa, anthra or isopurpurine are certainly formed, although not in exactly considerable quantities; to prove it, I followed the directions of Perkin for anthrapurpurine. The coloring matter resulting from the fusion and which has been precipitated and washed, is treated with a solution of soda and shaken with freshly precipitated (and washed) hydrate of alumina. On filtering, the purpurine goes into solution; what was in solution was again precipitated and treated in the same manner, and this repeated several times. After thus treating it three times its quantity was considerably lessened, but there was still isopurpurine present. That the coloring matter obtained from bibromanthraquinone contains isopurpurine is also shown by the enclosed swatches dyed with the (thoroughly washed) raw product. You could not have a more excellent chemical assistant for America than Dr. Arno Behr, who has been my assistant for some time, and is at present in America.

Messrs. Caro and Glaser certainly know him, if not personally, at least through his scientific works; he is an exceedingly competent, obliging and industrious man, well versed in alizarine matters.

Although at present engaged in a factory, he may perhaps be willing to act as expert by reason of his attachment to me. At all events he would not cause you very great expense, and being a real chemical expert might perhaps save to experts many useless experiments. I therefore give you his address for eventual use.

Dr. ARNO BEHR,
Care of Messrs. Maithiessen & Wiechers,
Sugar Refining Co.,
Washington Street,
Jersey City (N. J.)

The anthracene has arrived and I purpose making some experiments.

Respectfully,
(Signed) LIEBERMANN.

251 Berlin, d. 21. Dezember 1875.

Badische Anilin- und Sodafabrik in Ludwigshafen.

Daß Graebe und Liebermann, die Erfinder der künstlichen Alizarin-Darstellung, ihr preußisches Patent keineswegs wie Reimann behauptet, aufgeben mußten, weil sie zu beweisen unfähig waren, daß ihr Verfahren praktisch ausgeführt werden könne, wissen Sie, die Sie ja eine Zeitlang danach gearbeitet haben, selbst am besten. Folgendes ist der wirkliche Hergang, wie aus den mit der Patent-Behörde gewechselten Aktenstücken hervorgeht. Unser Gesuch vom 27. August 1869, um Patentirung des Sulfosäureverfahrens (als Verbesserung des früher ertheilten Patentes) wurde abgelehnt, da das zweite Verfahren dem ersten zu ähnlich sei, um eine Patentirung zuzulassen. Unsere Erwiederung, daß dann nothwendig doch das zweite Verfahren durch das erste Patent geschützt sein müßte, wurde unterm 23. November vom Ministerium dahin beantwortet, daß dies nicht der Fall sei, weil die Einzelheiten sich nicht deckten und auch gerade für die praktische Verwerthung die Abänderungen in's Gewicht fielen! Als wir auf die Wiedersprüche beider Bescheide aufmerksam machten, wurde nach längerem Drängen eine erneute Untersuchung der Sache vorgenommen, aber nun (am 13. Mai 1870) abschlägig beschieden, weil (in Folge unserer unterdessen natürlich an die Oeffentlichkeit gekommenen englischen Patente) das Verfahren schon veröffentlicht sei.

Es durfte nun Jedermann mit dem Schwefelsäure-Verfahren arbeiten, und da konnte uns nichts daran liegen, irgend etwas zur Aufrechthaltung des Brom-Patents zu thun. Deßhalb ließen wir das preußische Patent fallen, das dann unter dem 7. Juli 1870 aufgehoben wurde.

Hochachtungsvoll

Ihr ergebener

C. Liebermann.

(Translation.)

" Berlin, December 21st, 1875.

Badische Anilin and Soda Fabrik, at Ludwigshafen.

That Graebe and Liebermann, the inventors of the artificial alizarine production, were not by any means compelled to surrender their Prussian patent, as Reimann maintains, " because they were

unable to prove that their process could be practically carried out," you, who have practiced it for some time, know best yourselves. The following are the real facts of the case, as appears from the official correspondence had with the patent office. Our application of August 27th, 1869, for a patent for the sulfo-acid process (as an improvement on the previously granted patent) was rejected on the ground that the second process was held to be too similar to the first to admit of the granting of a patent. Our reply, that then necessarily the second process must be protected by the first patent, was answered by the Ministry on November 23d, to the effect that this was not the case because the details were not the same, and because for the practical application in particular the modifications
252 were important. When we called attention to the contradictions in the two decisions, after protracted pressure a re-examination of the matter was had, but then (May 13, 1870,) an adverse decision given, because (owing to our English patents, which meanwhile had, of course, been published,) the process was already published. Any one was then at liberty to use the sulfo-acid process, consequently we had no inducement for doing anything toward sustaining the bromine patent. For this reason we abandoned the Prussian patent, which was then revoked, July 7th, 1870.

Respectfully yours,

(Signed,) C. LIEBERMANN."

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

CITY AND COUNTY OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

STEPHEN P. SHARPLES, being duly affirmed, deposes and says: I reside in the city of Cambridge, Massachusetts, and am by profession a chemist. I was graduated from the Lawrence Scientific School of Harvard University in 1866, and was afterwards for three years assistant to the professor of chemistry in the same school. I have been for seven years engaged in the practice of my profession in Boston, and have been frequently called upon to testify in patent suits.

During the past three years I have made many tests of and experiments upon dyestuffs, and have given the subject of artificial alizarine my careful study.

I have read the depositions of Wm. Bogle, James Threlfal, Albert Horton, John Bracewell, Robert Henry, Henry Burrows, Thomas Walsh and Jas. Hunter, produced for the defendant in this suit.

Mr. Bracewell and Mr. Burrows and Mr. Walsh all say of madder colors, in effect, that no colors can be more permanent than they are, but Cruce Calvert, in his work on calico printing, Manchester, 1876, says, p. 87, of garacine, which is one of the madder prepara-

tions: "The colors (*i. e.* garancine colors) are not so fast, for they will not resist the action of light or of soap to the same degree as madder-dyed goods."

253 In fact, if these gentlemen, instead of making general statements so loosely, that madder colors are perfectly fast, had made tests, they would have found that no two preparations of madder, although dyed in the same manner and upon the same mordants, are equally fast. They must certainly all know that ordinary madder red, such as they produce on calico, is not at all comparable in fastness to Turkey red.

Mr, Hunter says, that "the colors are equally fast whether produced by madder preparations or artificial alizarine." He evidently has never tried the effect of severe soaping on colors produced with madder preparations, as compared with the same treatment on colors produced with artificial alizarine. If he had said that Turkey red is perfectly fast, and that ordinary red when produced with artificial alizarine, compares in points of fastness very favorably with it, no one would have disputed his words.

In order to show the relative fastness of various madder preparations and artificial alizarine, I have prepared swatches, hereto annexed, dyed with—

1. French madder.
2. Madder flowers.
3. Garancine.
4. Pincoffine, or commercial alizarine.
5. Meissonier's extract of madder.
6. Artificial alizarine of complainants.

These swatches were all cleared with soap in the usual way, and afterwards some of them were dipped into a solution of starch and ferricianide of potassium, (one part of ferricianide to ten of water,) dried, then dipped into a solution of caustic soda of 10° B, washed out, then boiled in water, afterwards soaped, washed and dried. The swatches show a great range in permanency, and they also show artificial alizarine to be the fastest of the lot with this method of treatment.

In mounting these swatches, I have put those that were merely soaped at the top of the cards, and under them I have put those that were treated with the ferricianide. In each case the lower swatch was a part of the upper before treatment with the ferricianide.

The position that he who first analyzes a body is its discoverer, is perfectly untenable. Abucarsis in the 11th century discovered alcohol or spirits of wine, but it was not analyzed until after the discovery of oxygen, a little over a hundred years ago.

Scheele discovered the green which bears his name in 1778, yet its true composition was never ascertained until it was analyzed by myself about two years ago.

The reaction—

Sugar. Alcohol. Carbondioxide.

$$C_6H_{12}O_6 = \begin{matrix} C_2H_6O \\ C_2H_6O \end{matrix} + 2CO_2$$

unable to prove that their process could be practically carried out," you, who have practiced it for some time, know best yourselves. The following are the real facts of the case, as appears from the official correspondence had with the patent office. Our application of August 27th, 1869, for a patent for the sulfo-acid process (as an improvement on the previously granted patent) was rejected on the ground that the second process was held to be too similar to the first to admit of the granting of a patent. Our reply, that then necessarily the second process must be protected by the first patent, was answered by the Ministry on November 23d, to the effect that this was not the case because the details were not the same, and because for the practical application in particular the modifications
252 were important. When we called attention to the contradictions in the two decisions, after protracted pressure a re-examination of the matter was had, but then (May 13, 1870,) an adverse decision given, because (owing to our English patents, which meanwhile had, of course, been published,) the process was already published. Any one was then at liberty to use the sulfo-acid process, consequently we had no inducement for doing anything toward sustaining the bromine patent. For this reason we abandoned the Prussian patent, which was then revoked, July 7th, 1870.

Respectfully yours,

(Signed,) C. LIEBERMANN."

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK *vs.* THOMAS K. CUMMINS. } In equity.

CITY AND COUNTY OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

STEPHEN P. SHARPLES, being duly affirmed, deposes and says: I reside in the city of Cambridge, Massachusetts, and am by profession a chemist. I was graduated from the Lawrence Scientific School of Harvard University in 1866, and was afterwards for three years assistant to the professor of chemistry in the same school. I have been for seven years engaged in the practice of my profession in Boston, and have been frequently called upon to testify in patent suits.

During the past three years I have made many tests of and experiments upon dyestuffs, and have given the subject of artificial alizarine my careful study.

I have read the depositions of Wm. Bogle, James Threlfal, Albert Horton, John Bracewell, Robert Henry, Henry Burrows, Thomas Walsh and Jas. Hunter, produced for the defendant in this suit.

Mr. Bracewell and Mr. Burrows and Mr. Walsh all say of madder colors, in effect, that no colors can be more permanent than they are, but Cruce Calvert, in his work on calico printing, Manchester, 1876, says, p. 87, of garacine, which is one of the madder prepara-

tions: "The colors (*i. e.* garancine colors) are not so fast, for they will not resist the action of light or of soap to the same degree as madder-dyed goods."

253 In fact, if these gentlemen, instead of making general statements so loosely, that madder colors are perfectly fast, had made tests, they would have found that no two preparations of madder, although dyed in the same manner and upon the same mordants, are equally fast. They must certainly all know that ordinary madder red, such as they produce on calico, is not at all comparable in fastness to Turkey red.

Mr, Hunter says, that "the colors are equally fast whether produced by madder preparations or artificial alizarine." He evidently has never tried the effect of severe soaping on colors produced with madder preparations, as compared with the same treatment on colors produced with artificial alizarine. If he had said that Turkey red is perfectly fast, and that ordinary red when produced with artificial alizarine, compares in points of fastness very favorably with it, no one would have disputed his words.

In order to show the relative fastness of various madder preparations and artificial alizarine, I have prepared swatches, hereto annexed, dyed with—

1. French madder.
2. Madder flowers.
3. Garancine.
4. Pincoffine, or commercial alizarine.
5. Meissonier's extract of madder.
6. Artificial alizarine of complainants.

These swatches were all cleared with soap in the usual way, and afterwards some of them were dipped into a solution of starch and ferricianide of potassium, (one part of ferricianide to ten of water,) dried, then dipped into a solution of caustic soda of 10° B, washed out, then boiled in water, afterwards soaped, washed and dried. The swatches show a great range in permanency, and they also show artificial alizarine to be the fastest of the lot with this method of treatment.

In mounting these swatches, I have put those that were merely soaped at the top of the cards, and under them I have put those that were treated with the ferricianide. In each case the lower swatch was a part of the upper before treatment with the ferricianide.

The position that he who first analyzes a body is its discoverer, is perfectly untenable. Abucarsis in the 11th century discovered alcohol or spirits of wine, but it was not analyzed until after the discovery of oxygen, a little over a hundred years ago.

Scheele discovered the green which bears his name in 1778, yet its true composition was never ascertained until it was analyzed by myself about two years ago.

The reaction—

Sugar. Alcohol. Carbondioxide.

$$C_6H_{12}O_6 = \begin{matrix} C_2H_6O \\ C_2H_6O \end{matrix} + 2CO_2$$

is frequently given to show that grape sugar splits up into alcohol and carbon dioxide, yet this by no means implies that carbon
254 dioxide and alcohol are the sole products of the decomposition of sugar when submitted to fermentation.

In fact, hardly an instance can be given in organic chemistry, when all the reactions take place and the products which form can be represented by any simple formula; and it is customary among chemists, when explaining or giving such reactions, to give only the principal ones, or such as may serve to illustrate the object they have in view.

Messrs. Græbe and Liebermann gave freely to the world the information that anthracene was probably the hydrocarbon from which alizarine was derived. If the method of deriving it, "simply adding two atoms of oxygen to anthrachinone," according to Dr. Chandler, was so obvious, why did not the many intelligent chemists of Europe proceed at once to add the two atoms of oxygen? Was it because they wished to allow Græbe and Liebermann all the honor? I think that the contrary of this is shown by the fact that as soon as Græbe and Liebermann divulged their process they had hosts of imitators, who sought in various ways to evade their patent.

The argument that Græbe and Liebermann only used certain well known reactions to arrive at the end at which they aimed has but little weight. By the skillful use of these they arrived at a result which was the production from anthracene of a dyestuff, which, in respect to its source and also in respect to itself as a product, was new both to the arts and to science. It was new as to its source, for although Laurent had dreamed that he could take coal tar and extract from it the coloring matter of madder, his dream was but a dream, and he started with entirely wrong ideas as to the materials from which the color was to be derived, and twenty years were spent in the vain endeavor to produce coloring matter from naphthalene, and even after anthracene was pointed out by Græbe and Liebermann as the true source no one seems to have taken any stock in it, until they demonstrated it and produced the dyestuff artificial alizarine from the waste product anthracene.

STEPHEN P. SHARPLES.

Subscribed and affirmed before me this 13th day of May, 1878.

[L. S.] W. HAUFF (10),
Notary Public, N. Y. city and county.

(6 sheets of swatches.)

255 Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

CITY AND COUNTY OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

HENRY MORTON, being duly sworn, deposes and says:

I have read the affidavit of Mr. G. Auerbach, entitled in the above

suit, dated the 25th day of March, 1878, in which he claims to be extensively acquainted with the practical manufacture of artificial alizarine and of alizarine from madder, and to be an acknowledged authority about these points scientifically.

As a matter of fact, however, Mr. Auerbach has not to my knowledge published anything about madder or its extracts which should give him any title whatever to call himself an authority on this subject.

The subject on which he is regarded in some sense as an authority is that of the substance isopurpurine, which he is supposed to have isolated from the new body artificial alizarine, discovered and made by Messrs. Græbe & Liebermann, and on some related matters bearing on the manufacture of artificial alizarine.

This present affidavit is, however, full of gross errors or misstatements as to elementary principles of chemistry and facts in that science.

Thus, Mr. Auerbach very energetically and repeatedly in this affidavit lays claim to priority in publishing the discovery, in artificial alizarine, of a body isomeric with the purpurine of madder, which he says Perkin some time after published about under the name anthrapurpurine.

Mr. Auerbach cites here his own date of first publication, as represented by the Moniteur Scientifique, 1872, No. 368, p. 686. This is in the August number of that journal for the year 1872.

Perkin's first publication about anthrapurpurine, in which he described its most important properties and how to get it, appeared in the Quarterly Jr. of the Chem. Soc. of London for 1870, or just two years before. Perkin, it is true, did not at this time publish an analysis, and therefore, in a technical scientific sense perhaps, had not discovered the substance with which he had dyed calico, &c.

However, if we turn to the Chemical News for June 14th, 1872, vol. 25, p. 284, in the report of the proceedings of the London Chemical Society of June 6th, or just about two months before Mr. Auerbach's earliest publication as claimed by himself, we
256 find as follows: "*A Note on a secondary coloring matter produced in the preparation of alizarine from anthracene*, was then read by the author, W. H. Perkin, F. R. S., in which he mentioned that he had carefully examined the secondary coloring matter mentioned in his paper on artificial alizarine, formerly communicated to the Society. It is soluble difficultly in most liquids, crystallizing from glacial acetic acid in minute masses of a yellow color. Its formula $C_{14} H_8 O_5$, is the same as that assigned to purpurine, but it differs from the latter in its reactions; its ethereal solution does not give the characteristic bands of purpurine, and it dissolves in alkalies with a violet color and not a red. It also differs from alizarine in its reactions, so that it must be considered as quite distinct, both from alizarine and purpurine."

If, therefore, Mr. Auerbach is right in his present assertion that his isopurpurine is nothing but the anthrapurpurine previously de-

scribed, separated and analyzed by Perkin, he simply destroys his only claim to an original discovery in this connection.

As a matter of fact, however, by following the process which he published in 1872, and having regard also to what Perkin had published about anthrapurpurine, I succeeded in separating from artificial alizarine two dyeing principles other than alizarine C_{14}, H_8, O_4, corresponding respectively with the properties assigned by Perkin to anthrapurpurine and by Auerbach to isopurpurine.

It is also well known that Schunck & Rœmer, Chem. News, Sept. 22d, 1876, p. 131, have published an investigation on a similar material, resulting in the extraction of two similar dyeing elements, which they call "anthrapurpurine of Perkin," and "flavo-purpurine," respectively.

Now granting for the sake of argument that Auerbach is right in stating that his original extract was only the anthrapurpurine of Perkin, and that through errors or uncertainties in his description, I, in following it with the light thrown on the subject by Perkin and by my own experience, have really separated anthrapurpurine and flavo-purpurine. What then? This work was done before the researches of Schunck & Rœmer were published, and when they came out I saw the possibility of such a result, but as I considered Auerbach to be the first in the field, I gave him the benefit of the doubt and allowed the name to remain, as I had failed to notice or attach any importance to his claim of anticipating Perkin's anthrapurpurine. That any such claim has been generally admitted, as Mr. Auerbach here asserts, by Schunck & Rœmer, Perkin and others, is simply not a fact. Perkin has treated the claim with the silent contempt which such an exhibition of ignorance deserves, while Schunck & Rœmer credit anthrapurpurine to Perkin, and likewise pass over Auerbach in silence.

As to other standard writers on the subject, the facts are as follows:

Crokes in his large work on Dyeing and Calico Printing, London, 187 , describes both anthrapurpurine as separated by Perkin, and isopurpurine as separated by Auerbach.

Bolly in his Handbook of Chemical Technology, Brunswick, 1874, vol. V., p. 534 et seq., recognizes both anthrapurpurine and
257 isopurpurine as different substances, but while fully describing anthrapurpurine as extracted by Perkin, does not once mention Auerbach's name. Napier, in his Manual of Dyeing and Dyeing Receipts, London, 1875, refers only to Perkin and his anthrapurpurine; so also does

O'Neill in his large work in two volumes, entitled The Practice and Principles of Calico Printing. Manchester, 1878.

Watts in his Second Supplement, London, 1875, mentions Perkin's anthrapurpurine very fully, but says nothing here or elsewhere of Auerbach or of isopurpurine.

Schorlemmer, in his Chemistry of Carbon Compounds, London, 1874, describes anthrapurpurine fully, assigning it to Perkin's in-

vestigations, but makes no mention whatever of Auerbach or of isopurpurine.

This is certainly not much like a general acknowledgment of Mr. Auerbach's claims or a recognition of his authority even on this limited subject. Even the title page of the English translation of his book by Prof. Crookes, which he refers to as his edition of 1875, reads as follows: "*Anthracen*, its constitution, properties, manufacture and derivatives, including artificial alizarine, antrapurpurine, etc., with their application in Dyeing and Printing," accepting Perkin's name for the substance, if there is only one, and ignoring Auerbach's.

Graebe and Liebermann, in their Vienna report, it is true, fall into the error of crediting Auerbach's unsupported and unfounded claims, and thereby show that the authors of a great and wonderful discovery are not ever afterwards infallible.

In reference to the present case, the only fact which I have regarded as important is the existence of two dyeing elements beside chemically pure alizarine in the product of Graebe & Liebermann's process, and whether these are or are not isomers of purpurine, or should be called anthrapurpurine or isopurpurine, or flavo-purpurine, and whether Mr. Auerbach really knew anything about the substance which he described as isopurpurine (a matter on which his affidavit throws grave doubt) is entirely foreign to the real issue.

In reference to his suggestion that my opinion of the practical difference between isopurpurine and anthrapurpurine was the result of imperfect experiment, I have to say that I carefully followed through his own and Mr. Perkin's methods for separating-out these bodies, and got out two substances in sufficient quantities to verify them with all the *distinctive* tests given by these two investigators, also to make specimens deposited as exhibits in the case of these complainants against the Hamilton Manufacturing Co. and against A. Cochrane & Co., and to make numerous dyeing tests.

As a result of these last are certain swatches, portions of which are deposited as exhibits in the same case, which show in a marked manner the difference between these two bodies as dyeing agents, and also the difference between either of them and purpurine from madder.

258 These separations were made in the first instance upon a quantity (about 10 lbs. of the paste) of commercial artificial alizarine, and the processes pursued made it impossible that such a substance as is described by Auerbach should be in the portion separated out by me as anthrapurpurine, or that a substance such as Perkin describes should have been obtained by me as isopurpurine. I therefore obtained two bodies, each of which was excluded from the other, by the treatment pursued, and which corresponded with the very dissimilar descriptions first published by Perkin and Auerbach respectively.

Having thus verified the methods, I next applied them to very much smaller quantities of artificial alizarine, which I had made my-

self from bibromanthrachinon. I obtained with this corresponding results, but of course the amount of each body was then very small, as in place of pounds I had to work with grains of raw material.

That either of these substances was identical with the purpurine of madder is a supposition simply absurd in view of the treatments by which they were obtained, and their reactions when separated out.

I consider that the results of my experiments so made conclusively prove that artificial alizarine made by the process of Graebe & Liebermann contains two dyeing elements other than alizarine, and that these are new bodies, not known to exist in any other substance and not identical with the purpurine of madder.

I here present, attached to this affidavit, three swatches, marked respectively *P*, *A*, and *I*, of which *P* is dyed with purpurine from madder, *A* with anthrapurpurine, and *I* with isopurpurine; or, if Mr. Auerbach repudiates the credit, flavo-purpurine, which will clearly show the differences of these materials as dyeing elements, especially in the violets and chocolate shades.

I have moreover seen three similar swatches prepared by Mr. H. Caro with like materials in 1876, and which exhibited the same differences in colors.

In this and in other connections Mr. Auerbach in his affidavit appears to make the absurd mistake that isomeric substances are identical, or that the proving substances to be isomeric has any force in implying they have any general identity of properties whatever.

Thus, as Mr. Auerbach himself says in his book on anthracene, London, 1877, there are recognized 9 substances isomeric with chemically pure alizarine $C_{14} H_8 O_4$, among which we find purpuroxanthin, either not dyeing, or giving yellow color; anthraflavic acid, which is not a dye-stuff at all, possessing no dyeing properties whatever, and iso-anthraflavic acid, also without dyeing properties. So we have as isomers starch and gum, turpentine and oil of lemons, acetic ether and butyric acid, anthracene and phenanthrene; indeed, examples might be given without number, but it is really unnecessary to go further in a subject familiar to every tyro in chemistry.

That Auerbach knew in 1872 that isopurpurine was not identical with madder purpurine—whatever this affidavit, which pur-
259 ports to be signed by him, now says—appears from his article in the Moniteur Scientifique of that year, p. 687, where he says: "By a sufficiently large number of reactions isopurpurine differs from purpurine, and these two substances cannot be considered to be identical." That he knew this in 1877 appears also in his book on Anthracene, pp. 195–204.

At folio 5 Mr. Auerbach falsely asserts that I had "pretended" that "isopurpurine and anthrapurpurine were not isomeric with purpurine from madder."

This is simply a falsehood, so conspicuous and without shadow of foundation, that I can only account for its presence by supposing that Mr. Auerbach is not familiar with the English language, and has been misinformed as to the actual contents of my depositions.

or of the meaning of this affidavit which he is claimed to have signed.

Again, Mr. Auerbach is not contraverting me, but only a man of straw of his own construction, when he asserts that "it is another mistake of Mr. Morton if he pretends that all alizarine from anthracene must and will contain iso (anthra) purpurine."

I have never asserted anything of the sort. I assert that all artificial alizarine made from anthracene by the process of Graebe & Liebermann will contain these bodies or their equivalents, but I do not doubt that some process of separation might enable a manufacturer, at the end, to get a part of his product as chemically pure alizarine.

This, however, would not be the product of Graebe & Lieberman's process, and the specimens of defendant's artificial alizarine examined by me was no such chemically pure alizarine as Mr. Auerbach here describes.

Mr. Auerbach's assertion that it is the temperature and not the quantity of alkali which determines the production of iso (anthra) purpurine may be quite true. I have never asserted the contrary, but have only said that when I used the larger proportion of alkali and the higher temperature I obtained that result. To which of the two it was due I did not pretend to say.

When Mr. Auerbach says that when I assert that by chemical means I am always able to find out whether a piece of cloth was died with alizarine from madder or from anthracene, he in the first place quotes me falsely and then shows by his remarks that he is ignorant of the proper tests to apply for the purpose.

What I do say is, that I can tell by chemical and optical tests whether a piece of cloth has been dyed with any madder preparation or with the product of Graebe & Liebermann's process commonly known as artificial alizarine.

I never said that if chemically pure alizarine was prepared from the two sources I could distinguish it or fabrics dyed with it, nor have I stated or implied that I depend upon the color of the dyed cloth for my result.

I use the spectroscope in conjunction with such other tests as are known to competent chemists generally.

How Mr. Auerbach found out that I "imagined" that an-
260 thracene was converted into isopurpurine by an excess of alkali he does not say, nor can I suggest, as I have never put any such "imagination" into words.

Where Mr. Auerbach says as follows: "Finally I recapitulate again that the purpurine made from madder (in practical use and the strict chemical sense of the expression) *is altogether identical with the purpurine made from anthracene*, of which not only samples, but casks, can be had at any time in New York at E. Sehlbach & Co., or Boston at A. Cochrane & Co., (see Schunck and Römer's experiments herein, De Lallande and Rosenstiehl's, etc.,") he not only states what proves to be a falshood, as will appear from the accompanying affidavits of Mr. Wm. E. Geyer and Prof. Sharples, but is

also guilty of a tricky attempt to insinuate a false impression without literal untruth which infinitely discredits him or whoever drew up this statement for him.

De Lallande and others have described a new process whereby they make by subsequent treatment, from alizarine, a product which they say is identical with the purpurine found in madder. If this is so, this is a body having nothing to do with isopurpurine, anthrapurpurine, artificial alizarine, the patent of Graebe & Liebermann or any thing else concerned in the present suit, and the introduction of this mention of it in this way can be described as nothing else than an attempt to mislead by a false suggestion.

In reference to this affidavit of Mr. Auerbach as a whole, I feel it only just to him to say that I cannot bring myself to believe that any one, with even the most elementary knowledge of chemistry and of chemical literature, could have composed or consciously indorsed such a document, and I am more ready to believe that Mr. Auerbach has been imposed upon, than to suppose that he could for any motive have disgraced himself by such a production.

I have also read the affidavit of Dr. Chas. F. Chandler in the case of the Badische Anilin und Soda Fabrik *vs.* T. K. Cummins, and do not find it possible to accept many of the statements and conclusions therein contained.

Thus in the first place I understand Dr. Chandler to say or imply that the word *alizarine* is confined exclusively when used in works on technical chemistry (by which I understand chemistry as applied to arts and manufactures,) to the simple or individual substance which was first separated from madder by Robiquet & Colin, in 1826, and which while indicated by various formulæ from time to time, was only *known* to have the formula $C_{14} H_8 O_4$ on the completion of its reduction by Græbe & Liebermann in 1868.

In my former affidavit in this case I have stated that besides this strict and limited signification the word *alizarine* was often used even by chemists, and especially by those who were familiar with the processes and materials used in dyeing and calico printing, to indicate the total dyeing principle of madder, even when that was known to include several other simple substances besides *alizarine* in the strict sense.

261 In that affidavit I have cited numerous examples of this use of the word, but will now add a few others.

Thus in Booth's Encyclopedia of Chemistry, 1850. After the usual strict definition we find as follows: "Madder has been examined by several others, and the experiments of Runge especially show that *alizarine* is not a simple color, and that madder contains several others."

In Ure's Dictionary of Arts, Manufactures, and Mines, 1866, V. II, p. 88, speaking of Koechlin's firm, the calico printers of Mulhausen: "Their *alizarine* is not a uniform substance, as it ought to be if a proximate principle, for samples obtained in different repetitions of the process have produced very variable effects in dyeing."

Dr. Chandler himself frequently uses the word in the same sense. Thus in his testimony in chief in the case of the Badische Anilin und Soda Fabrik *vs.* James Higgins, etc., October 6, 1875, page 15 of defendant's record, he says as follows, after enumerating fourteen processes for treating madder root: "These processes accomplish the extraction of *alizarine* from the madder root, yielding it in a condition, if not of absolute purity, yet sufficiently pure for use in dyeing and calico printing. Most of these processes have been employed on a manufacturing scale; some of them are still so employed, the products being *known in commerce* either as *alizarine or as madder extracts.*" (The *italics* are mine.)

Here evidently Dr. Chandler defines *alizarine* as the equivalent of madder extract, as indicating a commercial product only pure enough for use in dyeing or calico printing.

The same use of the word occurs constantly in this testimony of Dr. Chandler.

Again, in his article on "*Alizarine*" in Johnson's Encyclopedia, 1878, I find Dr. Chandler writing as follows, p. 100, near top: "*Alizarine* is largely sold to the calico printers in the form of a yellow-brown paste, under the name of 'madder extract'; also in the form of a dry powder."

Here we have the term *alizarine* applied as equivalent to "madder extract," which certainly is very far from being chemically pure *alizarine*, but is, on the contrary, simply a concentrated extract of the mixed coloring matters, not by any means pure at that.

This is precisely the sense in which I understand it to have been often used in the art and business of the dyer and printer, and in publications having reference thereto.

In the next place Dr. Chandler gives an account of the discovery of artificial alizarine by Græbe and Liebermann, which he has elsewhere described (Johnson's Encyclopedia) as "One of the greatest triumphs of modern chemistry," and as the "The brilliant discovery of Græbe and Liebermann destined to effect a very serious change in agricultural systems of people as remote from each other as the shores of the North Sea and Asia-Minor," and of which he further says: "The practical importance of this discovery attracted to it the attention of numerous chemists."

In this present affidavit, however, we have this "triumph of modern chemistry" and this "brilliant discovery" destined
262 to effect the world, and "attracting the attention of numerous chemists by its practical importance," reduced to a "process which never passed beyond the limits of experiment" and which seemed to consist in adding two atoms of oxygen to the anthrachinone of Laurent, "which they did by well known processes."

In face of statements so hard to reconcile as these, it seems to me best to simply state the facts of this discovery as they appear from historic records and documents.

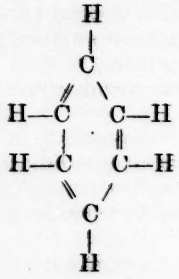
The artificial synthesis of alizarine had been for many years the subject of study and experiment. Roussin in 1861 thought he had

accomplished it, and about 1865 Martius and Griess had obtained a body from naphthaline supposed to be alizarine or an isomer of it.

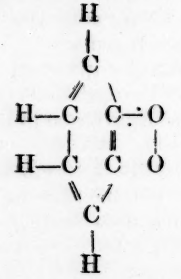
The general impression on all sides was that naphthaline would be the base of this product if it could be produced.

After this Chas. Graebe commenced his researches on the chinones, whose structure and relations to benzole he, after much energetic work, fully demonstrated.

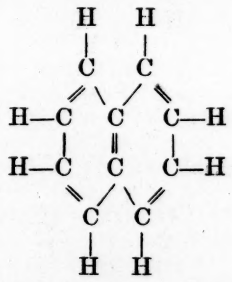
Benzole, according to the beautiful system of Kekulé, consisted of molecules, each one of which was constructed of six atoms of carbon linked in a ring, with one hydrogen atom saturating an outstanding bond from each, thus:



Now Graebe showed that the ordinary chinone was a modification of this, in which two of the hydrogen atoms were replaced by oxygen atoms whose remaining bonds saturated each other, thus:



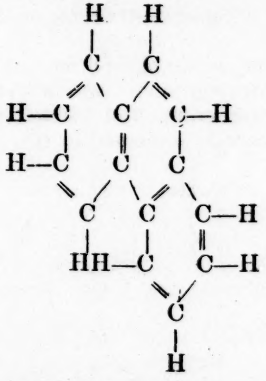
263 At the time Graebe commenced his researches no other analogous substance was known, but he soon added others to the list, and especially showed that the substance naphthaline which according to an extension of Kekulé's theory would be represented thus—



might form a naphthachinone by the substitution of two atoms of oxygen for hydrogen just as before.

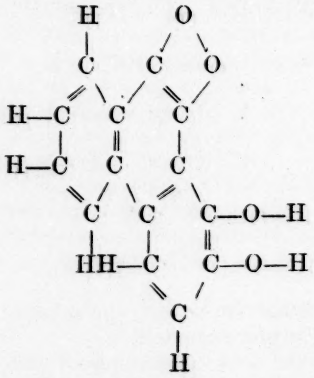
Various derivatives and compounds of this body were found to possess decided colorific properties, but yet were in no respect alizarine.

Analogy, however, suggested to Graebe and Liebermann that alizarine might be a chinone like them, but with another base. To discover this base they heated alizarine with zinc dust and obtained a body which careful examination showed them was anthracene, a compound which, on the same system, would be expressed as follows:



—being related to naphthaline just as that was related to benzole.

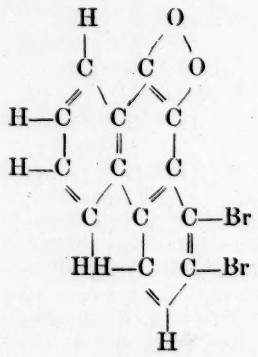
They next recognized in the body called anthracenuse by Laurent the chinone of anthracene. To convert this into alizarine there, however, remained not "to add two more atoms of oxygen" (see Chandler's affidavit in this case), but to "substitute two atoms of hydroxyl, OH, for two atoms of hydrogen" (see Chandler in
264 Johnson's Encyclopedia)—in other words to convert the substance into what is indicated by this figure—



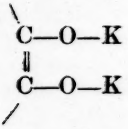
Simple as this substitution may appear on paper or as expressed in words, it required many experiments and patient work to effect it in practice.

Thus, though they had succeeded already in the case of benzole and naphthalene compounds in this dismemberment and replacement (this pulling off of hydrogen and hooking on of hydroxyl) without disintegration of the molecules acted upon, it by no means followed that the more complex molecule of anthracene would submit to such treatment without destruction or falling to pieces of its nucleus.

This substitution was accomplished by first introducing bromine in place of the two hydrogen atoms which were to be replaced and so getting the following compound (which however was only obtained by a series of steps as indicated in the patent)—

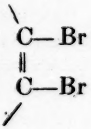


and then, by heating with caustic potash, causing *O*, *K*, to replace the bromine thus (I omit all but the modified part of the figure)—

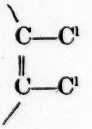


265 This was the alizarate of potassium, which, on the simple addition of a mineral acid, liberated alizarine.

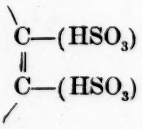
Now, when it had once been proved that this replacement of hydrogen (H) by hydroxyl (OH) could be accomplished without destruction of the molecule and with the production of alizarine, it followed as a matter of course that any of the well known agencies for effecting the same substitution might be employed in place of bromine. Thus, instead of forming bibromanthrachinon (for economy of space I will only represent that part of the molecule which suffered modification)—



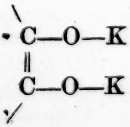
we might employ bichloranthrachinon—



or bisulphanthrachinon—



In each case the added atoms or molecules would simply yield their places on fusion with soda and the product, potassic alizarate, would result—



Here, then, as mere students of science, they had achieved the end of their work, they had effected the artificial synthesis of a complex and beautiful organic product, and such a "triumph of modern chemistry" might well absorb their whole attention. Its industrial application might well seem remote.

Anthracene, though present in a waste product to the extent of about 1 per cent. was in any available form as precious as gold and even less attainable. It was on about a pound, which they considered themselves very fortunate to secure, that this wonderful research was made by these discoverers. Nevertheless, in order that the world might enjoy some practical benefit from this great discovery, they did not rest. Their own means would not enable them to carry on experiments on a practical scale. Without a patent no manufacturer would risk the
266 necessary outlay. They therefore secured a patent, and as soon as they were able to obtain assistance from a responsible and powerful manufacturer, they proceeded to perfect their invention in a commercial form. This whole labor and achievement, however, is what Dr. Chandler describes as only adding two atoms of oxygen to Laurent's anthrachinone by well-known processes and patenting the same in practicable methods "which never passed beyond the limits of experiment," leaving it for another to "invent the process which forms the industry of to-day." Such is not what the facts express to my mind. On the contrary, I should express them as follows:

Messrs. Graebe & Liebermann, in 1868, made the most important chemical discovery and invention in industrial chemistry of the present century.

They discovered in the first place the true chemical structure of the dyeing element alizarine, $C_{14}H_8O_4$, and its relation in this respect to the waste product anthracene, which existed in the pitch formed by distilling coal tar.

They likewise discovered and invented a process by which they built up from the simpler chemical structure anthracene, the more complex body alizarine.

But this was not all. While the subject prominent in their minds was of course the synthesis of the pure chemical individual substance alizarine, $C_{14}H_8O_4$, their process of construction involved as a natural and usual accompaniment the formation of other organic products in addition to the one which they had in view, and in this case one or more of these bodies resembled alizarine, $C_{14}H_8O_4$, in being available as dyeing elements. Thus it came to pass that the product of their process, besides being of vast interest to the scientific world as an example of the artificial synthesis of a vegetable product, alizarine $C_{14}H_8O_4$, was also of importance to the arts of dyeing and calico printing as an efficient substitute for the complex dye-stuff madder extract, which, in addition to alizarine, $C_{14}H_8O_4$, contained purpurine, $C_{14}H_8O_5$, and some other bodies useful to it in practice as a dye-stuff.

Recognizing that their new product as a whole was a fit substitute

for madder preparations as a dye-stuff, Messrs. Graebe & Liebermann took out a patent for their process of preparing it. In this process one of the important steps consisted in the introduction of OH, called by chemists hydroxyl in place of H, hydrogen, in the molecules which were being built up. In the first instance they effected this step by the use of bromine or chlorine. They knew, as did chemists generally at the time, that if such a change could be effected by the use of bromine or chlorine, it could also be effected by the use of sulphuric acid. So perfectly well was this ability to effect such a change, *if the change could in fact be effected*, known to chemists, that in 1869, before Messrs. Graebe & Liebermann had published their process, but when they had only announced that they had reduced alizarine to anthracene by heating it with zinc dust, and had also reproduced alizarine synthetically from anthracene, Mr. Charles Lauth, in the Bulletin of the Chemical Society of Paris, March, 1869, Vol. XI., p. 271, wrote as follows (Deutsche Chemische Gesellsch, II., p. 14):

267 "At the last meeting of the Chemical Society of Berlin, Messrs. Graebe & Liebermann announced that they had succeeded in preparing alizarine artificially.

* * * "The authors have not as yet published their process; they merely state that they begin with anthracene. The year before, as one will remember, they had called attention to the fact that when alizarine (extracted from madder) is treated with zinc powder, anthracene is obtained, and from this they concluded that alizarine is derived not from naphthaline, as had always been supposed, but from anthracene.

"Alizarine may possibly be prepared by decomposing sulphanthracenic acid by means of soda. The phenol resulting from this reaction will probably be either alizarine itself, or a product which, under the influence of oxidizing agents, will yield alizarine."

That Graebe himself was specially familiar with just such reactions as the replacement of hydrogen (H) with hydroxyl, (OH,) appears from his own publications in 1867 of processes in which just such substitutions or replacements were repeatedly described.

I therefore consider that Messrs. Graebe and Liebermann must at that time have regarded sulphuric acid as a known equivalent for bromine or chlorine in carrying out this step of their process, and that to assume that such was not their opinion is to credit them with exceptional ignorance or blindness in this respect.

As to the quotation from Rieman, which Doctor Chandler adduces as the evidence which supports his view, I have to say, as I said before when cross-examined in the case of the Bad. An. und Sod. Fab. *vs.* Cochrane et al., that it does not state what is true.

This patent was not cancelled for want of proof of use, as asserted, but was abandoned by the inventors on account of vexatious delays and self-contradictory assertions on the part of the Prussian officials, which convinced them that their rights would be ignored.

In regard to Graebe & Liebermann's Vienna report, to which Dr.

Chandler also refers, I would say that this document was written by them in 1873, when the bromine form of their process, i. e., the form in which bromine was employed, in one stage, was no longer of any practical value to them, and indeed had become, in their minds, only a matter of historic interest, and when the maintenance of the same process with sulphuric acid, as a separate invention, was a matter of large financial interest to them.

This, together with the lapse of time and progress of events, would naturally color their views and insensibly modify their modes of expression. If, therefore, we find phrases which might at first sight seem inconsistent with the view of their discovery and invention which is given by their publications and statements made at the time of or immediately after their great achievement, we ought not to accept these latter literally or in such inconsistent sense, but give them credit for the modifying influences to which I have alluded, and seek, if possible, for an interpretation which shall bring them into accordance with the earlier and more reliable declarations.

268 If this is done there will, I think, be found nothing in the Vienna report which should modify the views of the invention and discovery of Graebe & Liebermann which I have already expressed.

The sulphuric acid modification of their process had superseded the bromine form so completely as to make the latter only a matter of historic interest to the manufacturer and even to the inventors, even though the vital principal of the later mode owed its existence and found its first expression in the earlier.

Again, it seems to me that the unsuccessful experiments of Graebe and Liebermann with sulphuric acid, alluded to in the Vienna report, were undoubtedly made after their association with Caro.

Then they, dividing the labor among themselves, Graebe and Liebermann made some experiments which, developing unexpected difficulties, they devoted their time to improving the practical details of the bromine method, which even in its original form, however, allowed them to manufacture on a commercial scale. While they were so doing, Caro overcame the small practical difficulty of not heating the mixture hot enough, and to him they generously give the fullest credit for this improvement in their process.

That the unsuccessful experiments with sulphuric acid were not made at the time of their first discovery, I think is shown by a number of circumstances.

1st. The entire silence of Caro and of Graebe in their declarations made in 1869.

2d. The entire silence of Graebe and Liebermann when (in 1870 in their long article of pages in the Ann. der Chem. und Pharm. Sup. vol. 7) they were giving to the scientific world a minute account of all their investigations in relation to this subject, among which such experiments would naturally have found a prominent place.

3d. The fact that their supply of anthracene with which their

whole investigation was conducted was too small to have allowed them to make more experiments of this nature than those they have described.

Dr. Chandler states further that the yellow flocks of alizarine precipitated from the product of Graebe and Liebermann's process have every appearance of pure alizarine.

It does not appear, however, from this affidavit or from his previous testimony that he has ever carried out this process himself; and in a previous deposition in the case of the Bad. An. & Sod. Fab. *vs.* J. Higgins, defendant's record, p. 72, answer 114, he shows that such a commercial product as Kopp's yellow alizarine, which is known to contain large quantities of purpurine, has the same appearance, in his opinion, as "all pure alizarine." Thus his judgment that the "yellow flocks" must be pure alizarine, because, in his opinion, they look pure, cannot be admitted to have much weight.

Dr. Chandler also refers to my forty-second answer in
269 cross examination in this case as supporting his opinion that when Graebe and Liebermann used the word alizarine in their patent they meant thereby chemically pure alizarine.

This, however, entirely misrepresents the true force of my said answer if taken in connection with my previous answers.

It will then appear that this answer was given in reference to an entirely different set of ideas and considerations from those which are involved in Dr. Chandler's citation.

I was first asked a purely hypothetical question as to the meaning of certain words if interpolated in the patent. I replied that they would be obviously misapplied and would have no proper meaning as so used. Then being asked as to the meaning of the words, *as words simply*, and if used by such men as Graebe and Liebermann, I replied that they would mean what such men knew to be "perfectly pure," namely, "chemically pure."

When the same subject in substance was brought up again, I explained the matter more fully, and showed how the use of the same words in a different order and with other matter between or connected with them would convey an entirely different meaning. To this, however, which is evidently my mature opinion, not on a supposed case which does not exist, but on the actual case in question, Dr. Chandler makes no allusion.

Dr. Chandler next alludes to the discussion which arose after Graebe and Liebermann's discovery as proving that they must have claimed that the product of their reaction contained no dyeing element but perfectly pure alizarine, and quotes a passage from an article by W. H. Perkin in support of his view.

Now, I admit, without hesitation, that this passage, taken alone, does convey the idea which Dr. Chandler implies, but I maintain, 1st, that this passage is at variance with the whole spirit and reasoning of the article at large, and is flatly contradicted by other passages in the very same article; as, for example, where Perkin explains that it is the identity of perfectly pure extracts from both

alizarines which he maintains, and states that the artificial alizarine as prepared and furnished to dyers is not at all pure. (See my answers 79 and 123 in this case.) His words are: "The coloring matter obtained either by Graebe and Liebermann's original process or from the sulpho acid of anthrachinon I have invariably called alizarine." Bearing in mind that this writer knew, *from his own experience*, that what he here indicates as "coloring matter" was not only not chemically pure alizarine, but contained a separable dyeing element, and that it was even practically distinguished from madder by the shade of color it produced in dyeing—all which appears in this same article—it seems to me beyond question that he here uses the word to indicate the entire product of the reaction as far as it was a dye-stuff, with the full consciousness that as such it contained other dyeing elements besides alizarine. He then continues: "The identity of this substance with the alizarine of madder has, however, been called in question."

Now, this might imply that the question was whether as a whole the two were identical, not only as regards the chemically
270 pure alizarine, but as regards all the "coloring matter" concerned. This interpretation, which even if accepted would refute Dr. Chandler's conclusion is, however, excluded by what follows, viz:

"I have therefore made some experiments on this subject, and carefully examined these two products side by side. For this purpose I have employed both *purified* sublimed and unsublimed artificial alizarine, and for comparison *purified* sublimed alizarine prepared from madder extract." (The *italics* are mine.) He then describes several tests, and concludes that the substances are identical; that is, that the *purified extracts* obtained from the alizarines or "coloring matters." (which he knew to be compounds,) were themselves identical. This result he evidently regards as deciding the question in dispute, which it clearly would not have done had that question been whether the product of Graebe & Liebermann's process was chemically pure alizarine identical with like alizarine extracted from madder. 2d, That as a *matter of fact* the discussion in question did not turn on the point claimed by Dr. Chandler, but was a dispute whether or not the product of Graebe and Liebermann's process did *contain as a part even* the alizarine found in madder.

This is at once evident from the reports of these discussions as given in the London Chemical News. Thus in vol. 21, pp. 43 and 44, in the report of the meeting of the Glasgow Philosophical Society, is a long paper by Mr. J. Wallace Young, in which I find the following:

"Mr. Young thoroughly tested the dyeing powers of the new alizarine by comparing the results produced upon mordanted cloth, either with equal weights of sublimed alizarine obtained from the two artificial preparations and from madder, and of purpurine. He showed the specimens of cloth so treated. Instead of the dark full

red, given by the natural substance, the artificial alizarine yielded only a yellowish red, much like that of purpurine."

* * * In a supplement to the paper of which the foregoing is an abstract, Mr. Young said that the manufacture of artificial alizarine is carried out in two or three ways by continental chemists, and from the examination which has been made of the products, it would appear that some of them consist of a mixture of alizarine and purpurine, in different proportions, and some of alizarine, or of a substance intermediate between the two."

Again on p. 67 of the same volume, we find in the account of proceedings of the same society on the 31st of January, 1870, a paper by Mr. John Christie, at the conclusion of which occurs the following (p. 69):

"He had found that selected crystals of artificial alizarine had only one half the tinctorial power of the natural product. He concluded by saying, that from the several experiments which he had made, his opinion was, that although the substance now sold as artificial alizarine may be the best attempt to produce the alizarine of madder by chemical means, in its present state it is far from being identical with it.

"A very animated discussion followed, in which Messrs. Anderson, Hogg, J. W. Young, Smith, Paterson and the chairman took part.

271 "Mr. Hogg strongly combated the opinion that the two products are not identical. He questioned the absolute purity of Mr. Christie's artificial alizarine, and said, that unless it was not only sublimed, but several times recrystallized from alcohol, it would be impure; and, further, that the coloration imparted to the alkaline liquor was doubtless due to the presence of another coloring matter which is known to be present in ordinary commercial artificial alizarine. He also stated that mordanted cloth dyed with pure artificial alizarine stands soaping better than that dyed with garancine; that was the testimony of many persons who had worked with the color.

"Mr. J. W. Young said that he had found that cloth prepared with the artificial alizarine would stand even boiling with soap.

"Mr. Smith stated that he considered that he had established the identity of the crystals of the two products by microscopic examination."

Again in the same journal (Chem. News,) vol. 23, p. 157, we have an article by E. Schunck, in which we find the following:

"The process itself, as described by its discoverers, Græbe and Liebermann, seems exceedingly simple, and consists in the conversion of the hydrocarbon anthracene, $C_{14}H_{10}$ by the action successively of an oxidizing agent, of bromine or sulphuric acid, and of caustic alkali, into alizarine, $C_{14}H_8O_4$. Nevertheless the product obtained on a large scale for the use of dyers and printers by this process is very far from being pure alizarine; so far, indeed, that some persons are inclined to doubt its perfect identity with the natural substance." * *

* * "Now a few simple experiments are sufficient to prove that artificial alizarine, as ordinarily prepared, is always accompanied by other substances, some of which are colored, while others are colorless or nearly so. My object on the present occasion is to describe one of these substances and to point out the relation in which it stands to alizarine.

"My attention was first directed to this part of the subject by the results of some experiments made on a small scale to obtain alizarine from anthracene, according to the direction of Græbe & Liebermann. I was surprised to find that in spite of all the precautions taken, I always obtained, besides alizarine, a notable quantity of another body, also crystalline, but dissolving in alkalies with a yellow color."

3rd. Græbe & Lieberman, in describing this very bromine method in the Ann. der Chem. und Pharm., 1870, supplementary vol. 7, p. 301, after describing the fusion with alkali, and the precipitation by acid, continue: "After being washed it is purified either by crystallization from alcohol or better, by sublimation."

From all these references we think it is indisputable that whatever Mr. Perkin may seem to assert in a particular passage, neither he nor any of the others who took part in this discussion were so little familiar practically with such reactions as to suppose it even probable that a chemically pure substance, or one without other related dyeing elements, was the result of such a reaction.

When Dr. Chandler asserts or implies that the use of cer-
272 tain formulæ by Græbe and Liebermann, in describing their process, implies that nothing but what those formulæ represent is present in the results of such reactions, he adopts a mode of interpreting such formulæ which is not in accordance with the general practice of chemists.

This I have already shown in my cross-examination in the present suit, ans. 112, and nothing is easier than to multiply illustrations of like effect by quotation from any book on organic chemistry; but not to spend time unnecessarily, I will simply quote a few examples from earlier publications of Græbe & Liebermann, showing that with these writers the use of such formulæ involved nothing of the meaning which I understand Dr. Chandler to state or imply.

If Dr. Chandler's words only mean that the formula for alizarine does not of itself imply the presence of something else, then his statement would be correct, but quite irrelevant to the present subject.

The quotations from Græbe and Liebermann, showing how they used formulæ to indicate only part of the reactions and bodies involved, are as follows:

Annalen der Chem. und Pharm., Supplementary volume 7, p. 278. Speaking of the bibromanthracenentetrabromide, they say: "According to Anderson's method, exposure of anthracene in thin layers to vapors of bromine, the preparation generally succeeds badly and the yield is small, there being formed brown sticky matters."

* * * *

"The action of bromine upon dry anthracene therefore corresponds to the equation"

$$C_{14}H_{10}+8Br=C_{14}H_8Br2Br_4+2BrH.$$

Here we have no notice whatever in the formulæ of the brown sticky matters, but no chemist would be deceived or be surprised after seeing such a formula to find them even if nothing had been said about them by the author.

Again, on page 268. "If anthracene bihydride is heated with concentrated sulphuric acid, there escape copious quantities of sulphurous acid while the anthracenebihydride is dissolved."

"After heating for a short time there is precipitated on addition of water a hydro-carbon which after crystallization from alcohol corresponds in melting point and other properties entirely with anthracene. Besides anthracene there are formed as secondary products from this sulpho-acids of anthracene. $C_{14}H_{12}+SO_4H_2=C_{14}H_{10}+2H_2O+SO_2$."

Here of all the products of this reaction the formulæ only indicate anthracene, water, and sulphurous acid, the sulpho-acids being omitted entirely.

In reference to Dr. Chandler's assertion that artificial alizarine when made as indicated in the formulæ quoted is as a fact chemically pure, I have to remark:

1st. It does not appear from anything in his testimony that Dr. Chandler has ever so made it, or indeed made it at all.

2nd. I have myself repeatedly so made it and have then never found it chemically pure, nor even free from other dyeing elements.

273 3rd. Schunck in the passage just cited says that he always found when preparing artificial alizarine by Græbe and Liebermann's process a notable amount of another body besides alizarine, also crystalline, but dissolving in alkalies with a yellow color.

4th. Græbe and Libermann themselves have put on record that they did not regard their product as chemically pure. Thus in the Ann. der Chem. and Pharm., Leip., vol. 7, already quoted, p. 301, in 1870, they say in reference to the fusion of bibromanthrachinon with potash:

"When the coloration no longer gains in intensity, and a sample taken out dissolves with a violet color, water is poured on the fused mass, the dark violet solution is filtered and then precipitated by an acid."

"The alizarine separated in flocks which are frequently light yellow but sometimes appear dark brown. After being washed it is purified either by crystallization from alcohol or better by sublimation."

Dr. Chandler further states that he has found no assertion in the literature of the subject that anthrapurpurine was found in the product of the bromine process.

The reason of this is obvious. The bromine form of process was

almost at once replaced by the cheaper sulphuric acid modification, and investigators therefore had no such large supply of the product obtained by bromine as would encourage them to look for new bodies in it in preference to the easily obtained and equivalent product made with the cheaper material.

Therefore the new bodies were naturally looked for and discovered in the later commercial products.

But when it became necessary to look for them there was no difficulty in finding them.

Thus in addition to my own experiments I would cite the following letter from Liebermann himself:

"BERLIN, 16. 11. 75.

Badische Anilin und Sodafabrik, Ludwigshafen.

In the fusion of bibromanthrachinon (from anthrachinon and potash), there is certainly formed even if not in exactly large quantities anthra- or isopurpurine.

To prove this, I proceeded according to Perkin's directions for anthrapurpurine. The dyestuff precipitated as usual from the "melt" and washed, was dissolved in soda solution and shaken up with freshly precipitated and washed hydrate of alumina. On filtering, purpurine goes into solution. The melt in solution was then again precipitated and treated in just the same way, and in this way several times.

After three treatments the quantity had indeed considerably diminished, but there was still isopurpurine present. That the dyestuff produced from bibromantbrachinon contains isopurpurine is also shown by the color of the dying test with the raw material, well washed (included)."

[There then follows matter relating to Dr. Baer, and the letter is signed:]

C. LIEBERMANN."

274 Moreover as early as March 17th, 1870, Græbe and Liebermann had come very near to the same thing, for in the Ann. der Chem. und Pharm. of that date they say: "A like oxidation seems also to lead sometimes to a slight extent in the fusion of bibromanthrachinon with potash to the formation of purpurine, but up to the present time we have not been able to prove this with absolute certainty.

After what I have shown to be the actual status of Mr. Auerbach in reference to his claim of anticipating Perkin in the discovery of anthrapurpurine, it is unnecessary to comment on Dr. Chandler's reference to the matter, further than to say that Dr. Chandler has evidently accepted Mr. Auerbach's claims as stated by himself and repeated by Græbe & Liebermann, without attempting any further investigation into the literature of the subject which would of co a have saved him from this mistake.

In connection with this reference to Auerbach and Dr. Chandler's

subsequent citation of him as one of the highest authorities it is curious to notice that in the American Chemist, edited by Dr. Chandler, there appeared in V. 3, p. 399, 1873, a notice of Auerbach's book in the editorial columns in which we find the following:

"The author of the book before us has collected a good many facts and gives a list of contributors, which however is not complete. It is evident, and for the reader no doubt unfortunate, that the author is not practically acquainted with the subject of which he treats." * * *

"To-day it is well known that a much larger quantity of anthracene can be obtained from pitch than from tar and large works are thus obtaining it both in England and in this country under a patent process. Of this fact the author appears to be entirely ignorant, as he quotes only Kopp's experiments in the Turin laboratory, which have no practical value."

* * * "The methods which are given for converting anthracene into alizarine are simply copies of different patent descriptions, from which the practical man can learn but little and which are well known to every chemist."

"Altogether the book is useful to a certain extent, but it is disappointing; the title page and the preface promise too much, the book itself gives too little."

It would thus appear that Dr. Chandler did not always place such reliance on Auerbach's authority as he seems to have done in this present instance.

As Dr. Chandler is here simply making, at second hand, an erroneous statement, it is a matter of small consequence.

When however he proceeds to assert or imply on the basis of such authority as this, that the two substances which I had isolated from artificial alizarine had shown to be different in their properties and reactions, and had deposited as exhibits in a former suit, were identical, simply because the names used were claimed by *such an "authority"* as Auerbach to indicate the same thing, he certainly carries hasty judgment beyond the limits of a safe discretion.

It is also evident that Dr. Chandler either did not recall the researches of Schunck & Roemer, proving the existence of two
275 dyeing elements in artificial alizarine, corresponding closely with those which I had extracted, or having them in mind, did not see their relation to, and support of, my statement; or he may have seen this and yet confined himself (as would of course be perfectly proper) to the simple correction of what he considered my oversight.

In either case his statement at folio 77 of his affidavit does not seem to me to carry much weight when the facts are understood.

When Dr. Chandler further states that anthrapurpurine is distinguished from madder purpurine, so far as it is a dyeing agent, only by slight differences in the color it will produce on mordanted cloth, he makes it appear that he has hardly given due attention to the

subject. Thus Perkin and others, at the very outset, observed that anthrapurpurine was as fast a dye as alizarine, while purpurine was relatively fugitive. This difference is most manifest to any one who has worked with them and is of vast practical importance, because it makes it possible to produce, with artificial alizarine, rich in anthrapurpurine, scarlet shades which shall be fast, while with madder such shades, due to excess of purpurine, will be fugitive. Again, the tints are not properly described by any one who has seen them as *slightly* different, unless our attention is confined to those with alumina mordant alone. When, therefore, Dr. Chandler asserts that anthrapurpurine, mixed with alizarine, will produce no effects which cannot be equally attained by certain preparations of madder, I reply that he only thinks so because he has not tried. While, therefore, I have never stated, and do not affirm, that in *every case* artificial alizarine will give results superior to those obtained with madder, I *do* assert that, taken *as a whole*, it is a superior material for the dyer and printer.

Had Dr. Chandler made experiments with swatches dyed with artificial alizarine and with madder and its preparations, and subjected them to the test recommended by Wagner, or to that published in the American Chemist, and to which his attention was called on cross-examination in the suit of the present complainants *versus* Higgins and others, he would have obtained results which would have modified his conclusions.

I herewith introduce six swatches showing the relative effects of the ferricyanide treatment of Wagner on some madder preparations and artificial alizarine.

In these No. 1 is dyed with madder-root, No. 2 with artificial alizarine, and No. 3 with Meissonier's extract of madder, simply soaped in the usual manner.

No. 1′ is the madder, No. 2′ the artificial alizarine, and No. 3′ the Meissonier extract swatch after the bleaching treatment. In this case, also, the treatment was identical to each and common to all the swatches.

I also introduce three other swatches, marked No. 1″, No. 2″ and No. 3″, which are likewise pieces of Nos. 1, 2 and 3, which have been treated with per-manganate of potash, as described in the American Chemist, 1875, p. 77, and in Dr. Chandler's deposition in the case of these complainants *vs.* Higgins and others. Defendant's Record, p. 64, cross-question 99.

276 Over and above these observations of practical results in the use of these substances in their ordinary commercial state, we have certain explanatory experiments which, to my mind, address themselves with great weight.

We know from direct observation that, as Rosenstiehl has so ably demonstrated, purpurine plays a very important part in the production of colors from madder, and is never absent from the finished goods. Its place in artificial alizarine is supplied by iso- and anthra-

purpurine, which, as the swatches heretofore appended prove, are brilliant dyeing elements.

Now, I have subjected another piece of the same swatches to the treatment with ferricyanide of potash, etc., devised by Wagner. (See Bulletin de Société Industrielle de Mulhouse, 1876, p. 124.) This process was adopted by him and used since by others as a convenient means of securing rapidly the same effects as are otherwise obtained in a long time by the washings and exposure to light, to which calicos are subjected in ordinary wear. My result shows that the purpurine is absolutely destroyed, while the anthra and isopurpurine are hardly affected or in some shades even improved. These swatches, treated not only alike, but immersed *actually together* in the various baths, and removed and washed all in a bundle, are evidence as to the relative fastness of madder and artificial alizarine colors which may be well left to speak for themselves. I will simply state that of the three swatches that marked P′ is the one dyed with madder purpurine, A′ that with anthrapurpurine, and I′ that dyed with isopurpurine.

HENRY MORTON.

Subscribed and sworn to before me, this 13th day of May, 1878, at

W. HAUFF (10),
Notary Public, New York city and county.

(Swatches.)

277 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS.

CITY AND COUNTY OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

CARL PICKHARDT, being duly sworn, deposes and says: I reside in New York city, and am a chemist by profession. I have read the Graebe & Liebermann patent, reissue No. 4,321, and have made artificial alizarine as many as six times according to the directions contained in said patent, using the bromine process; that I have dyed swatches of mordanted cloth with said artificial alizarine so made by me, and have also dyed swatches of the same mordanted cloth with madder extract (Meissonier's) and with garancine, and subjected all said swatches to the same treatment; said swatches are hereto annexed, and are six in number, as follows:

Swatches A and A′ were each dyed by me with said artificial alizarine as one piece and in the same bath; swatches B and B′ were each dyed by me with madder extract (Meissonier's), as one piece and in the same bath; swatches C and C′ were each dyed by me with garancene, as one piece and in the same bath; said swatches

A, B and C were afterward merely washed with soap; said swatches A,′ B,′ and C,′ were afterward boiled in a soap bath, and then placed together for about five minutes in a solution of ferricyanide of potassium, and then removed and squeezed out and put into a solution of caustic soda for about five minutes, and then taken out and put into boiling water, and then soaped and dried. The above treatment with ferricyanide of potassium is according to the method devised by Wagner and published in the Bulletin de la Société Industrielle de Mulhouse for February and March, 1876, p. 126.

This method, it should be noticed, is not a merely arbitrary test, but has been adopted by Wagner and others because they found it to produce, in a short time, the same effects as resulted from a long exposure to the ordinary bleaching influences of light, air, and washing.

CARL PICKHARDT.

Subscribed and sworn to before me, this 13th of May, 1878.

W. HAUFF,

[L. S.] *Notary Public, New York city and county.*

(Swatches.)

278 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
T. K. CUMMINS.

Stevens Institute of Technology,
HOBOKEN, N. J., *May 13th*, 1878.

STATE OF NEW JERSEY, COUNTY OF HUDSON, *ss.*

On April 23rd, 1878, I read the deposition of G. Auerbach stating among other things:

"Finally I recapitulate again that purpurin made from madder (in practical use and the strict chemical sense of the expression) is altogether identical with the purpurin made from anthracene, of which not only samples but casks can be had at any time in New York at E. Sehlbach & Co., or Boston at Cochrane & Co., (see Schunk and Roemer's experiments herein, De Lallande and Rosensteihl's, etc.)" On the same day I went with Mr. Haskell to E. Sehlbach & Co., Liberty st., New York, to get some of this purpurin. Mr. Sehlbach stated that they had no purpurin. On my stating that I had read of a "purpurin made from anthracene" and wanted to get this I was told that they had none. Mr. Sehlbach stated that they had no purpurin of any kind.

WILLIAM E. GEYER.

Sworn to and subscribed before me this 13th day of May, 1878.

CHARLES MEYER, Jr.,
Notary Public of N. J.

279 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

HENRY MORTON, being duly sworn, deposes and says:

That annexed hereto are four pieces of printed cloth, mounted upon a card entitled "Hunter's Swatches," and which were given to deponent by Adolf Kuttroff on the 13th day of May, 1878; that the two pieces upon the left hand side of said card under the words "artificial alizarine" are parts of the same piece from which the piece annexed to said Kuttroff's affidavit in this suit, dated May 13, 1878, and marked "artificial alizarine," was taken, and that the two pieces on right hand side of said card, under the words "madder extract," are parts of the same piece from which the piece annexed to said Kuttroff's affidavit was taken and marked "madder extract;" that after receiving the same from said Kuttroff deponent divided the same and pasted on said card a piece of each swatch in the same condition as when he received the same from said Kuttroff, and subjected the other pieces to the treatment with ferricyanide of potassium, etc., devised by Wagner as a test of fastness of colors, to which he has referred in his affidavit of May 13th, 1878, folio 362, and that the said pieces so tested are attached to said card in their appropriate places, directly under the pieces from which they were taken by him as above stated, and under the names of the dyestuffs "artificial alizarine" and "madder extract," with which the same were said to be printed respectively.

Deponent further says that before making the above test he cut off a small piece from each swatch and boiled these pieces separately in alum water and examined the solution with the spectroscope and found that the one said to have been dyed with madder extract gave the absorption bands, which he has invariably found in all madder preparations or goods dyed therewith, when similarly treated, while the solution obtained from the piece said to have been dyed with artificial alizarine showed no such indications.

Deponent further says that while the swatches were still moist with the mucilage with which they were attached to said card, he laid a blotter upon them to rest his hand in writing the names above them and that said blotter having been in use before, produced upon the swatches the slight black stains which are there to be seen.

HENRY MORTON.

Sworn to and subscribed before me this 14th day of May, 1878.

W. HAUFF, (10)

[L. S.] *Notary Public, New York city and county.*

(4 Swatches annexed.)

280 Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE AND OTHERS.

NEW YORK, *May 4th*, 1878.

J. VAN SANTVOORD, esq.:

Dear Sir:—Please take notice that on Wednesday next, at the opening of the court, we shall move the court for a rehearing of the above entitled cause upon papers and affidavits, copies of which have been served upon you in the motion for injunction in the case of the same complainants against T. K. Cummins, and upon such other papers as we shall serve before the coming on of the motion. Yours, truly,

DICKERSON & BEAMAN,
Solicitors for Defendants.

281 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE & CO.
In Equity.

To the honorable the Justices of said court:

The petition of Alexander Cochrane respectfully represents that, since the argument of the above entitled cause, he has discovered new evidence which, as he believes, will make it certain that the invention of Graebe & Liebermann was that of a process for producing perfectly pure alizarine, and was not an invention of a composition of matter.

This was not known to him at the time when the testimony closed in this case, and has been discovered since. It was not in this country at the time, and has been derived from examination made in Europe for the purpose of ascertaining the truth.

Your petitioner, therefore, prays that the case may be opened for the purpose of admitting such new evidence.

ALEXANDER COCHRANE.

CITY AND COUNTY OF NEW YORK, *ss.*

On this 6th day of May, 1878, before me personally appeared the above named Alexander Cochrane, to me known to be one of the defendants in the above suit, and who executed the above instrument in my presence, acknowledging that he executed it for the purpose therein mentioned.

WM. S. BEAMAN,
Notary Public, city and county of New York.

282 United States Circuit Court, southern district of New York.

THE BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE & Co. } In equity.

STATE OF NEW YORK.
City and county of New York, } *ss.*

Alexander Cochrane, being duly sworn, deposes and says: I am the defendant in the above-entitled cause; I am a merchant, and have sold alizarine which was manufactured in Germany, as I am informed by the manufacturers and believe, by a process substantially different from that which is described in the patent of Graebe and Liebermann, on which this suit is brought.

When a claim was made against me that I was infringing the said patent, I submitted the facts to Messrs. Dickerson & Beaman for an opinion, and was advised, in a written opinion, that the reissued letters patent of Graebe & Liebermann were void in law, and that it was no violation of that patent to sell alizarine manufactured by a different process from that described in said patent.

A motion for injunction was made in this court against me, and was, as I am informed and believe, argued by the counsel for the complainant on the one side, and decided by the court without calling upon my counsel, on the ground that the reissued letters patent were void on their face.

After that decision the complainants proceeded to take testimony, and examined several witnesses, and particularly Professor Morton, who, as it appears, had been employed by them for the purpose
283 of making chemical researches, which occupied him for a whole year, and who had testified to certain facts which he claimed to have ascertained by such extended and laborious examination; I then caused inquiries to be made for the purpose of ascertaining whether there was any chemist in this country who had made the investigations Professor Morton claimed to have made, and who could be called as a witness, but I was informed that no other person in this country had made such investigations, and that it would require a great length of time and labor to repeat the experiments made by Professor Morton.

In this state of the facts, and relying upon what I believed to be the decision of this court on the validity of the reissued patent, no testimony was taken in my behalf in this cause, and it came on for hearing before his Honor Judge Wheeler, in the February term of this year.

After the cause had been called for hearing, and when it was about to be heard, his Honor Judge Shepley, in the first circuit, decided on the same patent in another case in which there was no testimony for the defendants, and in which the testimony for the complainants was substantially the same as in my case, that the word

alizarine in the said reissued letters patent did not signify the chemical compound known to chemists by that name, but that it signified a composition of matter composed of alizarine, anthrapurpurine and isopurpurine, which had been invented by the patentees. This decision was founded upon the testimony of Professor Morton, and which I had at that time no means of disproving.

Since the closing of the testimony of my case and its submission to this court, however, I have become informed of certain facts which directly contradict the testimony of Professor Morton, and which were not accessible to me when the testimony was closed. These facts appear in certain affidavits, copies of which I hereto annex, and which, if I have the opportunity, I should be able to prove by the examination of the witnesses who have made the said affidavits.

I also submit herewith a copy of the cross-examination of Professor Morton, who has been cross-examined by the counsel for Mr. T. K. Cummins, in a suit against him by the same complainants, under the said patent, and whose cross-examination was
284 conducted by the assistance of the facts and information contained in the said affidavits, to show that the said original patent of Graebe & Liebermann was and is a patent for alizarine, which, as a dyestuff, was perfectly pure, having the formula C_{14}, H_8, O_4, and was not a patent for any composition of matter whatever, and that the word *alizarine*, in the said patent, had no other or different meaning from that which was given to it by the chemists who first isolated alizarine and who gave it its name.

ALEXANDER COCHRANE.

Sworn to and subscribed before me, this 6th day of May, 1878.

WM. S. BEAMAN,
Notary Public, City and County of N. Y.

285 U. S. Circuit Court, southern district of New York.

BADISCHE ANALIN AND SODA FABRIK
vs.
A. COCHRANE & Co.

J. VAN SANTVOORD, esq.,
Complainant's Solicitor, New York City.

SIR: Please take notice that at the hearing of the motion for a rehearing herein, we shall refer to the petition and affidavits of Alexander Cochrane, one of the defendants herein, and also to the affidavits filed in behalf of the defendants in the suit of Badische Analin and Soda Fabrik *vs.* T. K. Cummins & Co., in the Massachusetts circuit; and also to the testimony of Professor Morton, as already taken and printed in that case; and also to various documents which have been collected in a pamphlet entitled "Professors Graebe and Liebermann on Artificial Alizarine."

We hand you herewith copies of the several papers hereinabove referred to.

NEW YORK, May 24, 1878.

Yours, &c.,

DICKERSON & BEAMAN.

(Endorsed.)

Service of copy of the within and of all the documents therein referred to is hereby admitted.

J. VAN SANTVOORD,
Complainant's Solicitor.

NEW YORK, May 24, 1878.

286 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et als. } In equity.

Affidavit of G. Auerbach.

I, the undersigned G. Auerbach, citizen of the kingdom of Great Britain, residing at present at Elberfeld, depose and say as follows, under oath:

Replying to the affidavit of Prof. Morton, dated 13th May, 1878, I intend to ignore his personal attacks against me, by which he tries to strengthen his assertions and simply show the mistakes and misstatements contained in said affidavit.

Regarding my position as an authority in matters relating to anthracene and its derivatives, I refer Prof. Morton to his own statements, dated 15th April, 1878, cross-question 20, etc., in which he quotes me as an authority, and even places me before Mr. W. H. Perkin. (See cross-q. 26.)

Page 52 of his affidavit of May 13, 1878, line 258, etc., say:

"The subject," etc.—till line 259—while on page 53 of the cross-examination of Prof. Morton, line 240, and page 54, till line 252, this gentleman acknowledges me distinctly as an authority for isopurpurine and even for anthrapurpurine and purpurine.

It is true that I have sent my investigations on isopurpurine to the Moniteur Scientifique at the beginning of July, 1872, but they were already completed in March, 1872, and communicated to the late Dr. Gessert, so that I could not have any knowledge of Mr. Perkin's investigations in the same direction.

287 It is very singular, and speaks little for the impartiality of a witness that he should quote me as a witness as long as it suits his purpose, and shortly after asserts the contrary when I take an opportunity to correct his mistakes and erroneous statements. Mr. Perkin has been treated in the reversed but similar manner by Prof. Morton. In the answer to cross-question 26, Prof.

Morton throws doubt upon Mr. Perkin's impartial judgment, and hints at personal interest and affidavit, page 53, line 264–265; Prof. Morton says: "Perkin has treated the claim," etc. As to Schunk and Roemer's passing over Auerbach in silence (Prof. Morton's statement, page 63, line 264) they say the contrary, namely, Berichte der Deutchen Chem. Gesellschaft, 1877, p. 1821, remark 2:

"We shall call in future the trioxyanthraquinone, derived from isoanthraflavique acid, which was first discovered by Auerbach and afterwards by Perkin, isopurpurine, following the example of Mr. Liebermann."

Page 53, line 265: Mr. Crookes' statement is easily explained. In a book giving information of printing and dyeing it cannot be expected that long statements about identity of isopurpurine and anthrapurpurine are given.

Bolly refers in his Handbuch, vol. V, Diteratur, p. 18, Capitel V, to anthracene and its derivatives, Moniteur Scientif, 1872, T. XIV, 681, which contains my work

It is easily understood that in England publications Perkin's name of anthrapurpurine has become more familiar, and on account of this fact I authorized Prof. Crookes, when he translated my book on anthracene in 1877, to adopt the name of anthrapurpurine, as it was identical with isopurpurine. If my work had been translated in 1872 I believe the name of isopurpurine would have been adopted and become familiar in England.

Page 54, line 268: Is very absurd, and Prof. Morton has the arrogance to say that he knows Graebe & Liebermann's ideas better than these gentlemen themselves, the same as Prof. Morton pretends to know better what Graebe & Liebermann wished to patent than they themselves know it. And, moreover, Prof. Morton refers, as above mentioned, himself to my authority.

The further lines till 269: "In reference to the present case," &c., are again personal attacks upon me, to which I do not intend
288 to reply. Prof. Morton contradicts himself again, saying: "That I carefully followed through his own," &c.

Prof. Morton then goes on to speak at length about the impossibility of the identity of iso (anthra) purpurine with purpurine from madder, and because in my affidavit of March, 1868, I mention that *isopurpurine* and *anthrapurpurine are identical*, but *isomeric*, with purpurine from madder, it suits him to mix these two statements, and to write as follows, lines 273–274:

"In this and in other," &c. Such nonsense is not contained in my statement, line 275; "that Auerbach knew in 1872," &c., is intended to make the impression as if I had made a different statement in my affidavit of 25th March, 1878, from what I said or wrote before. That is another mistake. What I say is expressed quite clear and distinct in my affidavit of 25th March, 1878, page 34, line 39, and page 35, line 91, &c., which say: "No claims has so far ventured," &c., and "Perkins who sometimes after," &c., lines 277–278. "Again, Mr. Auerbach," &c., is a personal remak, which I

shall only answer by facts. After reading this, I construct his remarks slightly different from what I did before.

All his former assertions and statements were nicely calculated to tend in one direction, viz., to make out that Graebe & Libermann's patent, which has been bought by the Badische Analin & Soda Fabrik, covers not only pure alizarine, same as found in madder, and which, as Prof. Morton *now* admits, *can* be made from anthracene, but is a new composition of matter; and in order to find ingredients for such composition they say that iso (anthra) purpurine, and flavopurpurine are always present in alizarine, whether this may be made by the bromine, chlorine, or sulphuric acid process, or by any other process for making alizarine. Hereby and by the following statement of Prof. Morton the validity of the United States patent is simply reduced to the chlorine or bromine process. Page 46, answer to cross-q. 70, l. 219, Prof. Morton says:

"I have asserted and I do believe that the manufacture of artificial alizarine *by the use of sulphuric acid is the same process* as the manufacture of artificial alizarine by the use of bromine, involving *simply the substitution for the bromine* of a substance known to be its equivalent in such reactions at the time of the invention.

289 Liebermann, p. 31, line 152, in his letter to the Badische Analine and Soda Fabrik, admits the uselessness of the bromine process, and took out the sulphuric acid patent invented by Graebe, Liebermann and Caro, and at the same time by Perkins. If this had been a mere substitution, the patent in England would be entirely void, because, as Prof. Morton seems to imagine, it was covered by the bromine process.

Prof. Morton, in answer to cross q. 64, p. 46, line 211, admits that no doubt alizarine makers would use the sulphuric acid process in preference, because it is cheaper than the bromine process. I certainly believe that no alizarine maker, since 1870, has worked according to the patent, and neither the plaintiffs or any alizarine maker has made alizarine after the bromine process for the market, and it seems absurd that the present owners of this valueless United States patent now claim a monopoly for artificial alizarine, with the wrong pretension that the possession of the patent be just, because the imported alizarine contained by-products (iso (anthra) purpurine), which justify the name composition of matter, by-products which, as Prof. Morton admits himself, and according to *all* Messrs. Graebe & Liebermann's own publications about that subject, were discovered and investigated *two years* after the discovering of the chlorine, bromine, sulphuric acid process by me and Perkins.

Page 56, line 279, Prof. Morton says: "When Auerbach says," etc., Morton contradicts himself in his answer to cross q. 7, page 25, line 114: "As a chemical substance it is new in its composition, containing notable quantities of anthra purpurine, iso purpurine, and other substances which do not exist in madder root or its preparations," etc.

This certainly shows that Prof. Morton considers artificial aliza-

rine different from madder preparations. In answer to cross-q. 49, p. 39, line 184, he says: "If I had the opportunity to applying a very simple test I do not believe that I should fail to pick out, *in every case*, a piece of cloth dyed with madder and an alumina or iron mordant."

Now, as according to Prof. Morton's previous statement, madder preparations are different from artificial alizarine, the consequence is that if his very simple test does not answer, the piece must be dyed with artificial alizarine, and as he says:

"I do not believe," etc., the statement in my affidavit of 25th March, 1878, was perfectly true and correct, because Prof.
290 Morton can only find out a difference with those cotton goods which are dyed with a yellowish shade of artificial alizarine (made from the bisulfoacid of anthraquinone,) when comparing it with a blueish shade dyed from madder or garancine, or blueish alizarine from madder, because when he compares a yellowish dyed cotton good dyed with madder or garancine, or a yellowish alizarine from madder, he is not able to find such a difference, which he himself agrees he cannot do, page 56, line 219, "I never said," etc.

Line 280: "How Mr. Auerbach," etc. Here Prof. Morton, whether intentionally or not, makes a serious mistake in reading my statement of 25th March, 1878. I never said that Prof. Morton imagines that anthracene could be converted into isopurpurine by an excess of alkali. What I say, page 37, line 99, of my affidavit, is: "A surplus of alkali added does, however, not do the slightest harm, because the alizarine which once has been formed during the melting process cannot again be afterwards converted into isopurpurine by an excess of alkali, as Prof. Morton imagines it does."

That Prof. Morton really imagines alizarine can be converted into isopurpurine by treating the first with an excess of alkali, this impression is certainly made by his answer to cross-question 118, page 64, line 284, where he says: "The amounts of material which I was able to prepare did not enable me to make quantitative analysis of the products. All that I have found was that when I worked with large quantities of alkali at a high temperature I obtained a product which, when treated by the method given by Perkin and Auerbach for separating out isopurpurine and anthrapurpurine, gave a larger yield of the materials separated out from the alizarine," etc.

Page 57, line 281: Wm. E. Geyer and Prof. Sharples applied for purpurine to E. Sehlback & Co. and A. Cochrane & Co., and were unable to obtain it. The affidavit of Mr. Sehlback will explain this matter. When I said that purpurine from anthracene was identical with purpurine from madder, I did so in order to show that from anthracene coloring matter could be prepared even identical with purpurine from madder, and not only coloring matters isomeric with the same. By no means I believe the trioxyanthraquinones obtained by Graebe & Lieberman's patent to be identical with madder purpurine, as Arno Behr imagines I do. Now, even if Prof. Morton has

altered his earlier opinion and withdraws the authority granted
291 to me by himself in several cases, for his not being acquainted with anthracene and its derivatives, speaks distinctly the use of wrong formulæ for anthraquinone and alizarene, formulæ which, by Graebe and Liebermann, and all other chemists, have been proved to be wrong, and to represent the phenanthrene; also, and still far more, his assertion in answer to cross-question 158, page 78, line 346: "Thus, for example, it could not be asserted beforehand that bromine could be made to replace just two atoms of hydrogen if it had replaced four, and the subsequent substitutions by potash and hydroxyl had taken place with them, the resulting substance would have been rufagallic acid (!) in place of alizarine." This is the crowning point of anything stated by Prof. Morton, who seems to imagine that rufegallic acid has the formula $C_{14}H_8O_6$, whilst every chemist knows that rufegallic acid has the formula $C_{14}H_8O_8$.

The explanations of Prof. Morton regarding what he calls (or pretends to call) perfectly pure alizarine, in answer to cross-question 41, page 36, line 170, to page 37, line 174, and cross-question 82, page 51, line 232, are contradictory in themselves, and entirely opposed to what Graebe & Lieberman have asserted in all their publications and patent specifications.

C. GUSTAVE AUERBACH.

Sworn and subscribed to before me, in the consulate of the United States at Barmen, the 5th day of July, 1878.

[SEAL OF CONSULATE.] EDGAR STANTON,
No. 1344. *U. S. Consul.*

292 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et als. } In Equity.

Affidavit of Charles Hunter.

I, the undersigned, Charles Hunter, partner in the firm of J. C. Harter & Co., in Manchester, in the county of Lancashire, in the kingdom of Great Britain, hereby declare on oath as follows:

I have read the assertions of several American witnesses in the suit in equity, "Badische Anilin and Soda Fabrik *versus* T. K. Cummins," in the United States Circuit Court, district of Massachusetts, that turkey red colors, dyed with alizarine made from anthracen, were faster and brighter than turkey red colors dyed with madder or madder derivatives—in fact that is was impossible to obtain with madder derivatives the same rich and bright shades as are obtained from alizarine made from anthracen.

The firm of J. C. Harter & Co. has sold madder derivatives for more than sixty years, and alizarine made from anthracen for about four years, and I have always been informed that the coloring principle of madder is the same as the coloring principle of alizarine

from anthracen; that the same shades can and are obtained with madder derivatives and alizarine from anthracen, and that it is simply a matter of price whether the one or the other or both are used for producing turkey red dyes or prints.

In order to ascertain whether the assertions of the American witnesses were true or not I went, on Friday, the 26th of July,
293 1878, to Accrington, in Lancashire, and called at the works of Messrs. Fred. Steiner & Co., turkey red dyers and printers; the works are situated at Church, near Accrington. As is well known to all parties in the turkey red trade or connected therewith, Fred. Steiner & Co. have, for more than thirty years, produced the finest and best shades of turkey reds, which have never been equaled, far less surpassed by any turkey red dyer in Great Britain or elsewhere. I entered into conversation with Mr. James Kerr, who has been for years the managing partner of the firm, and asked him whether, from his experience as a practical turkey red dyer and printer, the above assertion was correct, namely, that he could get with alizarine from anthracen finer and brighter shades of turkey red than with madder preparations; or whether he could get with alizarine from anthracen such shades of turkey red as it was impossible to obtain with madder preparation at all. His reply was given without the slightest hesitation and with great emphasis: "That the reverse was nearer the truth; that for some styles, where a full red shade was required, they had obtained better results with madder than with alizarine made from anthracen, but yellow shades could not be produced so well with madder as with alizarine from anthracen." In support of his opinion, Mr. Kerr gave me swatches of cloth, which I attach to this affidavit. No. 1 was dyed in 1866 with a madder preparation; No. 2 was dyed in 1878 with alizarine from anthracen. I purposely asked for a swatch dyed previous to 1868, when the process for making alizarine from anthracene became known. To anybody who is a judge of colors it is quite clear that the swatch dyed with madder is brighter and more delicate, but that they both are very fair specimens of turkey red work.

I further asked Mr. Kerr why he had not continued to use madder only in his dyes, and why he had substituted alizarine from anthracen in its stead, and his reply was: "As far as the color produced is concerned I can use either the one or the other; it is only a question of price. Madder dyes are at present more expensive than dyes with alizarine from anthracen, and the extra price which I can get for madder dyes is not in proportion to the additional cost."

Lastly, I asked Mr. Kerr whether he would sign an affidavit containing the above views, but he answered that on some former occasion he had done so, but had found that his time had been so much
294 taken up and his business been interfered with, that he had to decline this request. He then added that I had his full permission to sign an affidavit containing everything he had told me.

I have read the foregoing part of this affidavit to Mr. Kerr, and he concurs with it.

[SEAL.] C. HUNTER.

Signed and sealed in the presence of—

ARTHUR C. HALL,
And SYLVESTER FLAGLER,
U. S. Consular Clerks,
Manchester, Eng.

(Stamped Seal.) (Attached Seal on the cloth.) (Stamped Seal.)

American Consulate, Notarial, Manchester. American Consulate, Notarial, Manchester. American Consulate, Notarial, Manchester.

Swatch No. 1; Turkey red, dyed with madder preparation in 1866, by Fred. Steiner & Co.

Swatch No. 2; Turkey red, dyed with alizarine from anthracen, by Fred. Steiner & Co., in 1878.

UNITED STATES CONSULATE,
Manchester, England.

Know all whom it may concern, that on this twenty-ninth day of August, 1878, personally appeared before me, C. Hunter, of Manchester, England, to me well known to be the person described in the foregoing instrument, and duly executed the same by signing his name thereto in my presence, and in the presence of A. C. Hall and Sylvester Flagler, witnesses, declaring that he did so freely for the purposes and to the interests therein set forth, and acknowledged the same to be his free act and deed.

In testimony whereof, I have hereunto signed my name and affixed the seal of this consulate this twenty-ninth day of August, 1878, and in the 103d year of the Independence of the United States.

[SEAL.] ALBERT D. SHAW,
United States Consul.

295 United States Circuit Court, southern district of New York.

BADISCHE ANILIN UND SODA FABRIK
vs.
A. COCHRANE et als. } In Equity.

Affidavit (translation) of Dr. P. Romer.

I, the undersigned, Dr. P. Romer, 26 years old, have studied chemistry in Wurzburg, Tubingen and Berlin, have been engaged in alizarine factories since 1873, where I was occupied exclusively with scientific researches on alizarine and with its production on a manufacturing scale.

Having been requested to give my opinion whether it be possible

to make alizarine according to the so-called bromine process (patent of Graebe & Liebermann) which is perfectly pure and free from by-products, I hereby declare, in lieu of oath, that it is quite possible to do so, and I use for that purpose the following operations:

I prepare, first, bibromanthracen from anthracen by adding 4 atoms of bromie.

$$C_{14}H_{10} + 4Br. = C_{14}H_8Br._2 + 2HBr.$$

I treat this product (dibromanthracen) with other 4 atoms of bromine and receive as product bibromanthracen tetrabromid:

$$C_{14}H_8Br._2 + 4Br. = C_{14}H_8Br._2Br._4.$$

This latter product I can obtain by the method of Anderson (as mentioned in Graebe & Liebermann's United States patent No. 65,465, 5th October, 1869,) by allowing to act 8 atoms bromine upon 1 molecule of anthracen, thus:

$$C_{14}H_{10} + 8Br. = C_{14}H_8Br_2Br_4 + 2Br.H.$$

296 If I heat this bi-bromanthracen tetra bromine to about 200° C, bromine and a compound of bromine and hydrogen are set free, and what remains is tri-bromanthracen $C_{14}H_7Br_3$.

$$C_{14}H_8Br_2 = C_{14}H_7Br_3 + BrH + 2Br.$$

If I treat this tri-bromanthracen with oxidizing substances, such as chromic acid, or bichromate of potassium and sulphuric or nitric acid, 2 atoms of bromine are liberated and are replaced by 2 atoms of oxygen, and the product becomes mono-bromanthrachinone: $C_{14}H_7BrO_2$.

$$C_{14}H_7Br_3 + O_2 = C_{14}H_7BrO_2 + 2Br.$$

When I heat this monobroman thrachinone with caustic potash or soda, bromine is replaced by hydroxyl, and I get mono-oxyanthrachinone:

$$C_{14}H_7BrO_2 + KOH = C_{14}H_7OHO_2 + KBr.$$

The next effect of the caustic would be to liberate hydrogen, by which part of the mon oxyanthraquinone would be reduced to anthraquinone, whilst another part would, under the oxidizing influence of the caustic be converted into alizarine.

$$2C_{14}H_7OHO_2 + KOH = C_{14}H_8O_2 \times C_{14}H_6(OH)_2O_2 + H_2O.$$

To prevent the above reduction, I add to the mono-bromanthrachinone along with caustics, strongly oxidizing substances such as chlorate of potash. The oxygen combines thus at once with the liberated hydrogen, and I get as an end product *pure alizarine:*

$$C_{14}H_7Br\ O_2 + NaHo = C_{14}H_7OHO_2 + NaBr.$$

$$C_{14}H_7(HO)O_2 + NaHO + O = C_{14}H_6 \left\{ \begin{matrix} HO \\ NaO, \end{matrix} \right\} O_2 + H_2O.$$

Or as an excess of alkali is always employed, I receive the neutral

soda salts of oxyanthraquinone, *i. e.* alizarine, which are decomposed (or precipitated) by acid, as is well known.

The alizarine thus obtained is perfectly pure and free from by-products,

$$C_{14}H_8O_4$$

It is identical with natural alizarine prepared from madder, and it is employed in dyeing and print works with the same effect as this.

I further declare that by using a larger or smaller quantity of caustic potash or soda in the melting or fusing process, or using a
297 higher or lower temperature, I obtain a larger or smaller quantity of alizarine, but the product so obtained (alizarine) cannot itself be altered by it, so that I *never can get*, by changing the temperature or the quantity of caustic soda, *anthropurpurine*, or, as it is also called, *isopurpurine*.

Whoever denies the above facts is either ignorant in those matters or he is not stating the truth!

I may also state that the bromine process of making alizarine from anthracen has never had a practical value, but only been of scientific interest.

After the first trials the bromine process was rejected by the alizarine makers as entirely worthless for the manufacture of alizarine on a manufacturing scale.

BARMEN, *5th August*, 1878.

(Signed) DR. P. ROEMER.

Affirmed and subscribed to in the Consulate of the United States at Barmen, before me, the 5th day of August, 1878.

[SEAL.] EDGAR STANTON,
U. S. Consul.

298 United States Circuit Court, southern district of New York.

BADISCHE ANILIN UND SODA FABRIK
vs.
A. COCHRANE et als. } In equity.

Affidavit (translation) of Dr. E. Schuler.

I, the undersigned, Dr. Edmund Schüler, am fifty years old; have studied chemistry in Bonn and Göttingen; was after that professor of chemistry at the Polytechnic in Zurich, and have been occupied since 1854 in chemical works.

Since the year 1870 I have engaged myself exclusively with scientific researches in connection with alizarine, and have been managing director of a factory for making alizarine for commercial purposes since that time.

Having been requested to give my opinion whether it be possible to make alizarine according to the so-called bromine process (patent of Graebe and Liebermann) which is perfectly pure and free from

by-products, I hereby declare, in lieu of oath, that it is quite possible to do so, and that I use for that purpose the following operations:

I prepare first bibromanthracen from anthracen by adding four atoms of bromine:

$$C_{14}H_{10}+4Br=C_{14}H_8Br_2+2HBr.$$

I treat this product (bibromanthracen) with other four atoms of bromine, and receive as product bibromanthracentetra bromid:

$$C_{14}H_8Br_2+4Br=C_{14}H_8Br_6.$$

This latter product I can obtain by the method of Anderson (as mentioned in Graebe and Liebermann's United States patent No. 95465, 5th Oct., 1869), by the allowing to act 8 atoms of bromine upon one molecule anthracen, thus:

$$C_{14}H_{10}+8Br=C_{14}H_8Br_2Br_4+2BrH.$$

299 If I heat this bibromanthracentetrabromide to about 200° C., bromine and a compound of bromine and hydrogen are set free, and what remains is tribromanthracen: $C_{14}H_7Br_3$.

$$C_{14}H_8Br_2Br_4=C_{14}H_7Br_3+BrH+2Br.$$

If I treat this tribromanthracen with oxidizing substances, such as chromic acid or bichromate of potassium and sulphuric or nitric acid, 2 atoms of bromine are liberated and are replaced by 2 atoms of oxygen, and the product becomes monobromanthrachinone: $C_{14}H_7BrO_2$.

$$C_{14}H_7Br_3+O_2=C_{14}H_7BrO_2+2Br.$$

When I treat this monobromanthrakinon with caustic potash or soda, bromine is replaced by hydroxyl, and I get monoxyanthrachinone.

$$C_{14}H_7BrO_2+KOH=C_{14}H_7OHO_2+KBr.$$

The next effect of the caustic would be to liberate the hydrogen, by which part of the monoxyanthraquinone would be reduced to anthraquinone, whilst another part would, under the oxidizing influence of the caustic, be converted into alizarine.

$$2C_{14}H_7OHO_2+KOH=$$
$$C_{14}H_8O_2+C_{14}H_6(OH)_2O_2+H_2O.$$

To prevent the above reduction I add to the monobromanthrakinon along with caustic, strongly oxidizing substances such as chlorate of potash.

The oxygen combines thus at once with the liberated hydrogen, and I get as end product *pure alizarine.*

$$C_{14}H_7BrO_2+NaHO=C_{14}H_7OHO_2+NaBr.$$

$$C_{14}H_7(HO)O_2+NaHO+O=C_{14}H_6\left\{\begin{matrix}HO\\NaO\end{matrix}\right\}O_2+H_2O.$$

Or as an excess of alkali is always employed, I receive the neutral soda salts of oxyanthraquinone (*i. e.* alizarine), which are decomposed (or precipitated) by acid as is well known.

The alizarine thus obtained is perfectly pure and free from by-products.

$C_{14} H_8 O_4$

It is identical with natural alizarine prepared from madder, and it is employed in dyeing and print works with the same effect as this.

300 I further declare that by using a larger or smaller quantity of caustic potash or soda, in the melting or fusing process, or using a higher or lower temperature, I obtain a larger or smaller quantity of alizarine, but the product so obtained (alizarin) cannot itself be altered by it; so that I *never can get* by changing the temperature or the quantity of the caustic soda, *anthrapurpurine*, or, as it is also called, *isopurpurine!*

Whoever denies the above facts is either ignorant in these matters, or he is not stating the truth!

I may also state that the *bromine* process of making alizarine from anthracen has never had a practical value, but only been of scientific interest.

The bromine process was rejected by the alizarine makers after the first trials as perfectly useless for the manufacture of alizarine on a manufacturing scale.

DR. EDMUND SCHULER.

5th August, 1878.

Affirmed and subscribed to before me, in the consulate of the United States, at Barmen, this fifth day of August, 1878.

[SEAL.] EDGAR STANTON,
No. 1,606 } *U. S. Consul.*

301 U. S. Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE et als. } In equity.

Affidavit of Gustav Auerbach (Translation).

I, the undersigned, Gustav Auerbach, have since 1871 occupied myself particularly and exclusively with the scientific investigation and the working of madder preparations (alizarine and purpurine) as well as with anthracen from coal tar, and its derivations, especially alizarine and iso-purpurine (also called anthra-purpurine). And I have published a work thereon, which is known to every chemist interested in the subject. (1st edition published by Seehagen, in Berlin; 2d edition, Longmans, Green & Co., London.)

After I had worked in this direction scientifically at Zurich I entered, in September, 1872, the alizarine works of Messrs. Gessert Brothers, at Elberfeld, as director of the chemical laboratory and of

the practical work in the factory connected therewith. In the same capacity I entered the alizarine works of Messrs. Brooke, Simpson & Spiller, in London, where I assumed, besides the laboratory, the technical direction of the whole works, and when these gentlemen sold their alizarine works to Messrs. Burt, Boulton & Hayward, of London, I continued in the same capacity with this firm.

Under my direction these works were considerably enlarged, affording me opportunity to conduct operations on a large scale; so that I can justly claim to be thoroughly acquainted theoretically and practically with alizarine from madder and alizarine from anthracen, as is already generally acknowledged among scientific men.

Having been asked in this connection to state whether it is possible to prepare, by the so-called bromine process, alizarine
302 which is perfectly pure and free from by-products, I declare herewith on affirmation that this is certainly possible, and that in doing this I employ the following operations:

I first produce from anthracen, by the action of four atoms of bromine, the bibrom anthracen, according to the following equation:

$$C_{14}H_{10} + 4Br = C^{14}H^{8}Br^{2} + 2HBr.$$

The bibrom-anthracen thus obtained, I treat with four more atoms of bromine and form bibrom-anthracen-tetra-bromide

$$C^{14}H^{8}Br^{2} + 4Br = C^{14}H_{8}Br^{2}Br_{4}.$$

This bibrom-anthracen-tetra-bromide I can also obtain by the method of Anderson, (which was referred to by Graebe and Liebermann in their American patent, No. 95,465, October 5, 1869,) when I allow eight atoms of bromine to act on one molecule of anthracen.

$$_{14}H_{10} + 8Br = C_{14}H_{8}Br_{2}Br_{4} + 2HBr.$$

I now heat this bibromanthracen-tetra-bromide to about 200° C., bromine and hydrobromic acid escape, while there remains behind tribromanthracen,

$$C_{14}H_{7}Br_{3}.$$

$$C_{14}H_{8}Br_{2}Br_{4} = C_{14}H_{7}Br_{3} + BrH + 2Br.$$

If this tribromanthracen is treated with oxidising agents, such as chromic acid, or what is the same thing, chromate of potash and sulphuric or nitric acid, then two atoms of bromine are expelled and two atoms of oxygen enter, and I obtain mono-bromanthraquinone.

$$C_{14}H_{7}BrO_{2}.$$

$$C_{14}H_{7}Br_{3} + O_{2} = C_{14}H_{7}BrO_{2} + 2Br.$$

If I now treat this monobromanthraquinom with potassic or sodic hydrate, there forms at first by the expulsion of bromine and entrance of our hydroxyl the monoxyanthraquinone.

$$C_{14}H_{7}BrO_{2} + KOH = C_{14}H_{7}OHO_{2} + KBr.$$

By further action of the alkali hydrogen would be set free, whereby the monoxanthraquinom would be in part gradually reduced to anthraquinone, while another part of the monoxanthraquinone, under the influence of the caustic potash or soda, is oxidised to alizarine.

$$2C_{14}H_{7}OHO_{2} + KOH = C_{14}H_{8}O_{2} + C_{14}H_{6}(OH)_{2}O_{2} + H_{2}O.$$

In order to prevent this I add at the beginning, in the treatment of

the monobromanthraquinone with caustic alkali, some oxidising agent, such as chlorate of patash. The oxygen set free on melting unites directly with the liberated hydrogen, and I obtain as final product *pure alizarine.*

$$C_{14}H_7BrO_2 + NaHO = C_{14}H_7OHO_2 + NaBr.$$

$$C_{14}H_7(OH)O_2 + NaHO + O = C_{14}H_6(HO)_2O_2 + H_2O.$$

303 As there is always an excess of alkali employed, I obtain the neutral sodium salt of oxanthraquinone or alizarine, which is then decomposed by the well-known method. The alizarine obtained in this manner is perfectly pure and free from by-products.

$$C_{14}H_8O_4.$$

It is identical with the natural alizarine obtained from madder, and has in its application in dyeing and calico printing exactly the same effects.

I declare further that by employing a greater or less quantity of caustic soda in the melting, with a higher or lower temperature, I obtain a greater or less quantity of alizarine, but the product obtained by this means is not altered in the least; that, therefore, by a greater quantity of caustic soda or a change in the temperature, anthra-purpurine (also called iso-purpurine) can never be obtained.

Whoever denies the above facts can do so only from ignorance or by misrepresentation of the truth.

Finally, the process of making alizarine from anthracen by the aid of bromine has no practical interest, but only a scientific one.

The bromine process was rejected in the alizarine factories after the first experiments as entirely worthless for the commercial manufacture of alizarine.

GUSTAV AUERBACH.

U. S. CONSULATE, *Barmen,* } *ss.*

I, the undersigned, consul of the United States of America for Barmen and its dependencies, do certify that, on the 22d day of August, 1878, at Barmen, the above-mentioned Gustav Auerbach subscribed the foregoing affidavit in my presence, and did swear and depose and swear that the matter therein set forth were true.

In witness whereof, I have hereunto set my hand and affixed the seal of this consulate the 22d day of August, 1878.

[SEAL OF CONSULATE.] EDGAR STANTON,
No. 1765. *U. S. Consul.*

304 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK *vs.* A. COCHRANE et als. } In equity.

Affidavit (translation) of A. Viefhaus.

ELBERFELD, 18 June, 1870.

I, the undersigned, August Viefhaus, partner of the firm J. C.

Duncklenberg in Elberfeld, the largest Turkey red yarn dyer of the continent, am practical Turkey red dyer and chemist; I live in Elberfeld, in Rhenish Prussia; have had the practical management of the Turkey red dye works of said firm J. C. Duncklenberg during 17 years; I am acquainted with all the details of Turkey red dyeing, and declare that we have during twelve years exclusively used garancene for dyeing fast Turkey red colors; if some person has asserted, as I have been assured, that fast Turkey red colors could not be produced with garancine, but only with madder or artificial alizarine, this statement is to be attributed to total ignorance or untruth.

Since artificial alizarine has competed with garancine as far as price is concerned, in fact it is now cheaper than garancine; I have almost entirely used artificial alizarine, and I obtain with it the same fast Turkey red colors as I obtained before with garancine.

My experience has proven to me irrevocably that *that* the blueish or yellowish-red tints of madder or garancine on the cotton fibre are quite *identical* with those blueish or yellowish red tints ob-
305 tained by alizarine from anthracen, that the last are as fast colors as the former, and the former colors as fast as the latter.

AUGUST VIEFHAUS.

Affirmed and subscribed to, in the consulate of the United States of America at Barmen, before me, this 19th day of June, 1878.

[SEAL.] EDGAR STANTON,
No. 1229. *U. S. Consul.*

306 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et als. } In equity.

Affidavit (translation) of Adolph Gauhe.

I, the undersigned, Adolph Gauhe, am a partner in the firm of Hoesterey & Gauhe, in Barmen, in Rhenish Prussia. My firm has been dyeing turkey red yarn for about sixty years. I personally have had charge, superintendence and control of the dye-works during sixteen years, and am intimately acquainted with all details of turkey red yarn dyeing.

I hereby declare, in lieu of oath, that in my dye-works garancine was used exclusively (as soon as it was introduced into commerce,) instead of madder, to dye fast turkey red colors. If somebody has asserted that fast turkey red colors cannot be produced with garancine, but only with madder or artificial alizarine, this assertion can only be based on gross ignorance or on disfiguration of the truth.

I produce (dye) the same colors with artificial alizarine as I used to dye formerly with the natural dyestuff as is contained in madder

and garancine, as is shown in two samples of turkey red yarn which were dyed in my works. Since October, 1872, I have made the first practical dye trials with artificial alizarine, and since the end of 1873 I have used artificial alizarine exclusively in my dye-works.

According to my whole experience there is no doubt that madder or garancine, dyeing blueish red or yellowish red shades on cotton fibre, are quite identic coloring matters as those produced by blueish red or yellowish red shades of alizarine from anthracine, and
307 as to fastness there is no difference between the colors produced by the natural or artificial dyestuff.

Barmen, 29th August, 1878.

ADOLPH GAUHE.

Yarn dyed, 1871, with garancine.

Yarn dyed with alizarine, 1878.

UNITED STATES CONSULATE, BARMEN (GERMANY.)

I, Edgar Stanton, consul of the United States of America for Barmen and its dependencies, do hereby certify, that on the 29th day of August, 1878, the above named Adolph Gauhe subscribed the foregoing affirmation, in my presence, in the aforesaid consulate, and did solemnly and truly declare that the matters therein set forth were true.

In witness whereof, I have hereunto set my hand and affixed the seal of this consulate, at Barmen, aforesaid, this 29th day of August, 1878.

EDGAR STANTON,
U. S. Consul.

[L. S.]
No. 1,805.
Fee, $0.50.

308 Circuit Court United States, southern district of New York.

BADISCHE ANILIN AND SODA FABKIK
vs.
A. COCHRANE et als.
} In equity.

Affidavit of Ernst Sehlbach.

I, the undersigned, *Ernst Sehlbach*, citizen of the kingdom of Prussia, residing in New York, at present sole partner of the firm of E. Sehlbach & Co., of New York, being on a visit to Germany, have been shown copy of an affidavit made by S. P. Sharples, of Cambridge, district o Massachusetts, dated Boston, May 1, 1878, used in a suit in equity, in the United States Circuit Court, district of Massachusetts, do hereby declare in lieu of oath that I had been cautioned by the European makers of purpurine, Messrs. Fr. Bayer & Co., of Barmen, to sell purpurine to *bona-fide* consumers only, as they had reason to suspect that application for purpurine would be made to me by persons acting for the Badische Anilin and Soda Fabrik;

that I have consequently given instructions to my clerks to be cautious, and to refuse information, samples, etc., of purpurine, except to persons known to them to be *bona-fide* purchasers and consumers; that I have had such applications, which were refused; that I have imported purpurine from anthracene, and still import, and will sell it. As a proof, I may mention that when I had imported purpurine from anthracene, date of Barmen invoice, April 3, 1878, I had a
309 little difficulty with the custom officers at New York, who thought purpurine was to be classed under aniline colors and not under alizarine.

Barmen, June 21st, 1878.

ERNST SEHLBACH.

Affirmed and subscribed to in the consulate of the United States of America, at Barmen, before me, this 21st day of June, 1878.

[SEAL.] EDGAR STANTON,
No. 1,249.] *U. S. Consul.*

310 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et als. } In Equity.

Affidavit (translation) of August Romer.

I, the undersigned, *August Romer*, owner of the two firms Peter Romer, Wme. in Barmen, and August Romer in Kratzau, in Bohemia, reside in Barmen, in Rhenish Prussia. I have been a practical turkey red dyer for twenty years, and I am acquainted with all details of turkey red dyeing. I hereby declare in lieu of oath, that for the production of fast turkey red colors I have formerly used madder, and after that for about 15 years, garancine exclusively. If anybody, as I have been assured, has asserted that it is impossible to dye fast turkey red colors with garancine, and that they can be *only* produced with madder or artificial alizarine, I can only say that such an assertion is either made from gross ignorance or from untruth.

I produce the same colors with artificial alizarine as I used to dye formerly with natural alizarine as contained in garancine or madder, as is shown by the two hanks attached, of which the one is dyed with garancine and the other with artificial alizarine. Since artificial alizarine has become so cheap as garancine, in fact cheaper, I have used exclusively artificial alizarine.

My experience has proved to me, without fear of being contradicted, that madders or garancines giving bluish or yellowish reds produce the *identical* colors on cotton fibre as are obtained by
311 alizarine from anthracen giving bluish or yellowish shades. and that there is no difference whatever in the fastness of turkey reds dyed with madder or artificial alizarine.

AUGUST ROMER.

Barmen, 30th July, 1878.

Affirmed and subscribed to in the Consulate of the United States, at Barmen, before me, this 13th day of July, 1878.

[SEAL OF CONSULATE.] EDGAR STANTON,
U. S. Consul.

No. 1549.

(Sample dyed with artificial alizarine.) (Sample dyed with garancine.)

312 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
COCHRANE and others.

CITY AND COUNTY OF NEW YORK, *ss.*

CHARLES F. CHANDLER, being duly sworn, deposes and says:

I have already made an affidavit in favor of the defendants in the case of the Badische Anilin & Soda Fabrik Company against T. K. Cummins, which affidavit I understand is part of the moving papers in the motion herein, and whatever is in said affidavit I now reiterate as true.

For the last six months I have been experimenting for the purpose of determining whether or no there is any difference between anthra-purpurine and iso-purpurine, and whether or no anthra-purpurine or iso-purpurine is one of the by-products of the process of making so-called artificial alizarine, as described in the Graebe & Lieberman reissued patent, dated April 4th, 1871, number 4321.

And also for determining whether some of the commercial alizarines for sale in the market were pure alizarines and free from anthra-purpurine and iso-purpurine in any appreciable quantities.

These experiments have been going on very continuously, and part of the time I have had two persons to help me.

I have found it very difficult to make, with any apparatus that has been at my command, artificial alizarine by the bromine process of Graebe and Lieberman, and I was only a few days ago able, for the first time, to obtain of the alizarine product what could be held in an ordinary teaspoon, and this small quantity of the
313 alizarine product was all I could obtain from one-quarter of a pound of bibromanthrakinon. This quantity, in my opinion, is too small to enable me to satisfactorily determine from it whether it contains any so-called anthra-purpurine or iso-purpurine, and from my own knowledge then I am to-day unable to say whether anthra-purpurine or iso-purpurine is a necessary by-product of the bromine process of Graebe and Liebermann.

I have carefully read the testimony in the various cases brought by the Badische Anilin & Soda Fabrik Company, both the testimony for the complainants and for the defendants, and I am familiar with the general literature with reference to the production of alizarine.

Graebe and Lieberman having discovered the composition of

alizarine. invented their bromine process, as set forth in their patent, for producing from anthracene this alizarine, the composition of which they had determined.

All the publications of Graebe and Lieberman in this matter show that they desired to produce nothing but pure alizarine.

The chemical formulas given by them in their publications, and in their patents, and in all their statements, show absolutely to a chemist that they only had one result in view, namely, the production of alizarine, which was known to them to be a definite compound, viz., C14, H8, O4.

The production of alizarine from anthracene in the way above referred to by Graebe and Lieberman is by all chemists considered a most brilliant triumph of synthetic chemistry, but this triumph consists in the fact that Graebe and Lieberman having discovered the constitution of alizarine from madder, were able from anthracene to produce alizarine of the same identical composition.

For some time chemists doubted that Graebe and Lieberman had produced alizarine, but Graebe and Lieberman always maintained that they had done so by the bromine process, and chemists generally now agree that Graebe and Lieberman by the bromine process did produce alizarine. The bromine process of Graebe and Lieberman never, as I understand it, went into any practical operation in a commercial sense.

Graebe and Lieberman began to prepare to produce artificial alizarine by the bromine process when what is known as the sulpho-acid process was discovered by Caro, working with Graebe and Lieberman in Germany, and by Perkin in England. The sulpho-acid process is not among chemists considered as
314 the same process as the bromine process of Graebe and Lieberman, for it involved invention over and above what was in the Graebe and Lieberman patent. By this I mean that though to chemists who read and understood the bromine process of Graebe and Lieberman it might occur that there were other processes by which alizarine could be made synthetically from anthracene, and yet the chemist who used the sulpho-acid process, and thereby discovered a process that was cheaper and more practical than the bromine process, invented something valuable.

There was some controversy in England, as I understand, between Caro on the one side associated with Graebe and Lieberman, and Perkin on the other, as to which was the first inventor of the sulpho-acid process, and finally the owners of the two patents exchanged licenses, and now the sale and production of alizarine from anthracene is controlled in England exclusively by the patents for the sulpho-acid process, although the English patent for the Graebe and Lieberman sulpho-acid process has been abandoned, and is open to the public, and if I am correctly informed, no artificial alizarine is now or has ever been made commercially by the bromine process of Graebe and Lieberman.

After the discovery of this sulpho-acid process of making alizarine

from anthracene, the production on a commercial scale at once began, and the alizarine so produced has to a very great extent superseded, by reason of its cheapness, madder products. Perkin in 1870 discovered that in the alizarine produced by the sulpho-acid process there was produced besides alizarine a by-product which he two years later called anthra-purpurine. About the same time Auerbach, in Germany, by independent observations, discovered that in the sulpho-acid process there was produced in addition to the alizarine a by-product which he called "iso-purpurine." Two years ago Schunk and Roemer, in England, discovered that by the same sulpho-acid process there was produced a by-product in addition to alizarine which they called "flavo purpurine."

Certain it is that Graebe and Lieberman never intended by their bromine process to produce iso-purpurine, anthro-purpurine and flavo-purpurine, or either of them. Certain it is that the existence of these substances was first discovered in the product—the sulpho-acid process. The existence of either of these substances in the pro-
315 duct of the bromine process is not asserted in any chemical work that I have ever seen, and I, as a chemist, see no reason to believe that either of them is produced in any appreciable quantity by the bromine process of Graebe and Lieberman. No chemist that I know of has ever stated that they are found there at all, except Professor Morton and Mr. Lieberman.

I have read carefully all that Professor Morton has testified to in regard to this matter, and my opinion is that his experiments relating to the product of the bromine process of Graebe and Lieberman have been made with such small quantities, he having, as he says, operated on "grains of raw material," that they are not entitled to be considered as having established the deductions which he makes from them.

All that I know about the experiments of Lieberman with reference to the point in question is that in 1875 he wrote a letter to the Badische Anilin and Soda Fabrik Company, which letter has been put in evidence by the complainants herein in the case against T. K. Cummins, and the original German of which letter and the translation made by the complainants I annex to this affidavit. This letter was evidently written by Lieberman after he had been asked by the Badische Anilin and Soda Fabrik Company, the complainants in this case, whether anthra-purpurine or iso-purpurine were certainly formed by his bromine process, and it is very evident from the letter that in 1875, at the time Lieberman was asked this question by the Badische Anilin and Soda Fabrik Company he had no knowledge of the fact in general, as the investigations of Auerbach and Perkin had been made with reference to the product of the sulpho-acid process. The letter also shows that after he made his experiments he reported that anthra-purpurine and iso-purpurine "are certainly formed, though not in exactly considerable quantities."

The words of original German letter are as follows:

"Beim Verschmelzen des Bibromanthracinons bilden sich allerd-

ings, wenn auch night genade betrachtliche Mengen, anthra-oder iso-purpurin."

I am familiar with the German language, and I understand that in this letter Lieberman says in substance that anthra or iso-purpurine are certainly formed by his bromine process, but not in any considerable quantities. The words of his letter seem to me to imply that the Badische Company had written to him asking him if they
316 were formed in considerable quantities, and that he, after his experiments, was unable to say that they were so formed, and made it as strong as he could when he said "not exactly in considerable quantities." "Considerable" in this sense, as I understand, means that he did not find them in any essential quantities.

My own experiments, to which I have already referred, have not been carried by me to such completion that I am able to give any positive statement of my own knowledge on this question which Liebermann answered as above quoted and which Professor Morton has answered after his experiments with a few grains, but as a chemist I see no reason, however, to believe that anthra-purpurine or iso-purpurine or flavo-purpurine, whether they are the same thing or different things, should be one of the by-products of the bromine process or are so in any appreciable quantities.

I have not finished my experiments for determining whether iso-purpurine, anthra-purpurine and flavo-purpurine are the same or different bodies. I understand Professor Morton to have come to the conclusion that anthra-purpurine is one thing and flavo-purpurine is another thing, and that iso-purpurine is either anthra-purpurine or flavo-purpurine or a mixture of the two "with some alizarine." In this respect I know of no authority with whom Professor Morton is in accord.

Auerbach discovered anthra-purpurine and Perkin discovered iso-purpurine, and these two discoverers, as I understand it, now agree that anthra-purpurine and iso-purpurine are the same thing, that is, they discovered the same thing and each gave it a name of his own.

Græbe and Liebermann, as I understand, agree that anthra-purpurine and iso-purpurine are the same substance.

A reference to the Vienna report of Mr. Liebermann will show this, and it is shown very conclusively in the extract of the letter from Liebermann to the Badische Anilin and Soda Fabrik Company already referred to, written seven years after his invention and when he was apparently for the first time investigating whether anthra or iso-purpurine were produced by the bromine process, which letter was translated by the complainants in this suit as follows:

"By the fusion of bibromanthrakinon (from anthraquinon) and potassa, anthra or iso-purpurine are certainly formed, although not in exactly considerable quantities; to prove it I followed the direction of Perkin for anthra-purpurine."
317 This extract shows that Liebermann considered anthra and iso-purpurine as two names for one substance, and that to determine whether that substance was formed he followed the direction

of Perkin for discovering whether anthra-purpurine was formed. He might equally as well have followed the direction of Auerbach for discovering whether iso-purpurine was formed.

It is evident, then, that the discoverers of anthra-purpurine and iso-purpurine, and Liebermann also, all agree that iso-purpurine and anthro-purpurine are the same thing.

In regard to the flavo-purpurine and its existence in artificial alizarine produced by the sulpho-acid process, I understand that Schunck and Roemer claim to have discovered in 1876 a substance in the product produced by the sulpho-acid process differing from alizarine and differing from anthra-purpurine, which they call flavo-purpurine, but I know of no investigator whatever who claims to have at all found it in the product of the bromine process.

I, therefore, as a chemist, see no reason whatever to believe that flavo-purpurine is produced in the production of alizarine by the bromine process of Græbe and Liebermann, and they certainly never intended to produce it, and never said they produced it, and have never to this day, to my knowledge, claimed to have produced it.

I am informed that there are various brands of artificial alizarine for sale in the United States, by the importers, and that these brands differ from each other in the fact that from their composition one or the other is better adapted for the dyeing of some peculiar shade of color. I do not know the difference in the composition of these different brands, and I judge that their composition and the method of their production is kept a secret by the manufacturers. I have examined one of these brands, such as is sold by T. K. Cummins & Co., and is known by them as brand No. 1. I have experimented with two hundred grammes of it—nearly half a pound. It has taken me more than three months to determine whether this sample contained any other dyestuff but alizarine, and with such experience as I have to-day, it would take me at least two months to determine whether another similar sample contained any other dyestuff than alizarine. This process of determination is very long, owing to the necessary method, which, to a great extent, consists in tedious filtrations and washings.

318 In making this experiment I have followed the process used and described by Professor Morton in his testimony for finding out anthra-purpurine and iso-purpurine, and I have obtained from this half-pound of artificial alizarine, brand No. 1, one-tenth of one per cent., or a thousandth part of the original material, which may or may not contain iso-purpurine, but I see no reason to think that this one-thousandth part of my sample does contain iso-purpurine. If it does it is in such inappreciable quantities as compared with the whole sample that it cannot with truth be said that the sample of alizarine furnished me contained anything of any essential importance in dyeing or calico printing except alizarine. I know of very few chemical products for sale that are so pure as this brand No. 1 is a pure alizarine.

From all I know in the matter there is no evidence or statement

that should satisfy a chemist that the product of the bromine process of Graebe & Liebermann contains any dyestuff in any useful quantity other than the well known alizarine C_{14} H_8 O_4.

C. F. CHANDLER.

Sworn to before me this day of November, 1878.

WM. S. BEAMAN,
Notary Public City and County of New York.

319 BERLIN, 16. 11. 75.

Badische Anilin und Sodafabrik in Ludwigshafen.

Beim Verschmelzen des bibromanthrachinons (aus anthrachinon und kali) bilden sich allerdings, wenn auch nicht gerade betraechtliche mengen anthra, oder isopurpurin. Zum Nachweis verfuhr ich nach den Angaben Perkin's fuer anthrapurpurin; der aus der Schmelze wie gewoehnlich gefaellte und ausgewaschene Farbstoff wird in Sodaloesung aufgenommen und mit frisch gefaelltem (und ausgewaschenem) Thornerdehydrat geschuettelt. Beim Filtriren geht das purpurin in Loesung; das in der Loesung befindliche wurde wieder gefaellt und ebenso behandelt, und so mehrmals. Nach dreimaliger behandlung hatte sich die menge zwar bedeutend vermindert, es war aber noch iso-purpurin vorhanden. Dass der aus bibromanthrachinon dargestellte Farbstoff isopurpurinhaltig ist, zeigt wohl auch die Faerbeprobe des (uebrigens voll staendig ausgewaschenen) Rpohprodukts (Leigt bei.) Einen vortrefflicheren chemischen Beistand fuer Amerika koennen sie gar nicht bekommen als den Dr. Arno Behr, welcher laengere Zeit mein Assistent war und sich gerade in Amerika aufhaelt. Er ist den Herren Caro und Glaser sicher wenn nicht persoenlich so durch seine wissenschaftlichen Arbeiten bekannt; er is ist ein ausgezeichnet faehiger und williger, fleissiger Mann, der die alizarinarbeiten genau kennt. Obwohl er augenblicklich sich in einer Fabrik befindet, wuerde er vielleicht den Auftrag als Experte zu fungiren, schon aus Anhaenglichkeit fuer mich, uebernehmen. Er wuerde Ihnen jedenfalls keine grosse Kosten verursachen, vielleicht als wirklicher chemischer Sachverstaendiger manchen unnuetzen Expertenversuch ersparen. Ich theile Ihnen desshalb zu Ihrem event. Gebrauch seine addresse mit.

DR. ARNO BEHR,
Care of Messrs. Matthiesen & Weichers,
Sugar Refining Co., Washington street,
Jersey City, N. J.

Das anthracen ist angekommen und habe ich die Anstellung einiger Versuche in Aussicht genommen.

Hochachtungsvoll,

LIEBERMANN.

[Swatches.]

320 (Translation.)

BERLIN, 16, 11, 75.

Badische Anilin and Sodafabrik at Ludwigshafen.

By the fusion of bibromanthrachinon (from anthraquinon) and potassa, anthra or isopurpurine are certainly formed, although not in exactly considerable quantities; to prove it, I followed the directions of Perkin for anthrapurpurine. The coloring matter resulting from the fusion and which has been precipitated and washed, is treated with a solution of soda and shaken with freshly precipitated (and washed) hydrate of alumina. On filtering, the purpurine goes into solution; what was in solution was again precipitated and treated in the same manner, and this repeated several times. After thus treating it three times its quantity was considerably lessened, but there was still isopurpurine present. That the coloring matter obtained from bibromanthraquinone contains isopurpurine is also shown by the enclosed swatches dyed with the (thoroughly washed) raw product. You could not have a more excellent chemical assistant for America than Dr. Arno Behr, who has been my assistant for some time, and is at present in America.

Messrs. Caro and Glaser certainly know him, if not personally, at least through his scientific works; he is an exceedingly competent, obliging and industrious man, well versed in alizarine matters. Although at present engaged in a factory, he may perhaps be willing to act as expert by reason of his attachment to me. At all events he would not cause you very great expense, and being a real chemical expert might perhaps save to experts many useless experiments. I therefore give you his address for eventual use.

Dr. ARNO BEHR,
Care of Messrs. Matthiessen & Wiechers,
Sugar Refining Co.,
Washington Street,
Jersey City (N. J.)

The anthracene has arrived and I purpose making some experiments.

Respectfully,
(Signed) LIEBERMANN.

320*a* United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK CO.
against
A. COCHRANE and others.
} In Equity.

SOUTHERN DISTRICT OF NEW YORK, *ss.*

C. HOWLAND, being duly sworn, deposes and says: I am a clerk with the firm of Messrs. T. K. Cummins & Co., merchants, of Boston and New York, and have been for nine years, and have had charge of their New York house for the past three years. One part

of their business is the sale of so-called artificial alizarine, received by them from Europe, and we have on hand now six brands of this artificial alizarine, known as No. 1, No. 2, No. 3, No. 4, No. 5 and No. 6.

The prices of these different brands vary somewhat; Nos. 2, 3 and 4 are generally about the same price, and Nos. 1, 5 and 6 are higher, but about the same each as the other. No. 1 is a brand that is used for pinks and purples. No. 2 is a brand that is used for reds and purples, "general work," as we call it. Nos. 3, 4 and 5 are used for different shades of scarlet and red. No. 6 is used for orange and brown. I do not know the difference in the composition of these particular brands, but I am informed and believe that No. 1 is a pure alizarine, and we sell it as such, and that the other brands differ from brand No. 1 and from each other in their composition.

I furnished Professor Charles F. Chandler, of New York city, a sample of brand No. 1 for analysis, and he has reported to me that it was pure alizarine and contained no appreciable quantities of anthra-purpurine or iso-purpurine. I do not know how it is produced, or how any of the brands that we sell are produced. We have had brands Nos. 1, 2 and 4 for sale from the beginning, that is for the last two years or more. Brand No. 3 we have had for sale for one year, and brands Nos. 5 and 6 for the last six weeks.

320*b* I know that Messrs. Pickhardt & Kuttroff, of New York, representatives in the United States of the Badische Anilin & Soda Fabrik, have for sale ten or a dozen brands of artificial alizarine so called, which vary from each other in the shades or tints of color they produce.

From correspondence that we have I understand that Messrs. Burt, Boulton & Haywood, of London, work under what is known as the English Perkin patent for manufacturing alizarine from anthracene by the so-called sulpho-acid process, and that they have also bought out the alizarine works of Perkin in England. The English patent of Perkin referred to is dated the 29th day of June, 1869, and that of Caro, Graebe & Liebermann of sulpho-acid process is dated the day before.

Under these patents the manufacture and sale in England of artificial alizarine by the so-called sulpho-acid process is controlled in England.

I annex hereto a copy of a letter dated the 15th day of October, 1878, from Burt, Boulton & Haywood to C. Neuhaus of Glasgow, which will show a recent transaction with reference to the sulpho-acid process.

C. HOWLAND.

Sworn to before me this day of November, 1878.

WILLIAM S. BEAMAN,

Notary Public, city and county of New York.

(Copy.)

64 CANNON STREET,
LONDON, 15*th October*, 1878.

Mr. CHARLES NEWHAUS, Glasgow:

"Alizarine Patent."

DEAR SIR: Having instituted legal proceedings against Mr. Broenner in the Scotch Law Courts, you are aware that we succeeded in seizing some moneys due to him from Messrs. J. O. Ewing & Co., and Messrs. Sterling & Sons, Dr. Clemm, Mr. Caro, Mr. Dixon and our London solicitors had several meetings last week, and our case was prepared to go to the courts. Subseqently, however, Mr. Broe-
ner came over to London and made an application to us to
321 stay proceedings. After consulting our lawyers, you will be glad to hear that we have obtained from Mr. Broener an unconditional submission, of which the following conditions are the principal ones, viz:

1st. He acknowledges the validity of our patent.

2d. He admits that he has infringed them, and that the alizarine that he has sold in England was made not by his patent, but by ours.

3d. He admits that the formation of the sulpho-acids is not possible by his patent.

4th. He engages that he will not grant any licenses under his patent, and that he will not send any more alizarine into the United kingdom, either directly or indirectly.

5th. He agrees to pay £100 damages for past infringements and £400 towards the legal expenses we have incurred, he paying his own costs besides.

We are further authorized by the agreement to give all publicity to the above engagements on the part of Mr. Broener. The agreement is a very strict and binding one, and we think it embraces every possible admission which could be desired from Mr. Broenner. We trust that you will approve of these arrangements made. We think we have got every possible condition which we could have got even by the most successful law suit, and, of course, this saving of expense is very great indeed. We shall be glad to hear from you on this subject, signifying your approval of the course we have taken. The agreement was only arrived at last night, and was duly signed by Mr. Broener, Dr. Clemm and by Mr. Boulton.

We are, dear sir,
Yours very truly,
(Signed.) BURT, BOULTON & HAYWOOD.

322 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In Equity.

In opposition to Rehearing.

CITY, COUNTY, AND STATE OF NEW YORK,
Southern district of New York, } *ss.*

WILHELM PICKHARDT, being duly sworn, deposes and says: That he resides in the township of New Lots, Kings county, Long Island, N. Y., and is one of the firm of Wm. Pickhardt & Kuttroff, dealers in dyes, etc., in this city, who are the agents of complainant in this country.

Deponent further says that ever since the year 1861 he has been a dealer in dystuffs, chemicals, and colors; that from the year 1864 to 1871 he was engaged in this country in the manufacture of chemicals and colors, and during that time had supervision of the factories belonging to him and his partner; that he was in Europe from April, 1877, to August, 1878, and during his stay there was frequently at the factory of complainant at Ludwigshafen, Germany, being there at different times, for longer or shorter periods, from one week to three weeks at a time; that he had frequent interviews and conversations with the directors and chemists of the various departments of the factory of complainant, particularly about the manufacture of artificial alizarine, among others with the chemists and technical directors of the artificial alizarine department, of which Dr. Glaser is and has been superintendent since 1870; that deponent had frequent conversations with Dr. Glaser about the U. S. patents, reissue Nos. 4320 and 4321, of Messrs. Graebe and Liebermann, for artificial alizarine, and the working of the methods described therein; that deponent asked Dr. Glaser to manufacture artificial alizarine according to the processes described in the patent, reissue No. 4321.

That in the months of June and July, 1878, deponent was at the factory at Ludwigshafen, and there in deponent's presence
323 Dr. Glaser manufactured and made yellow flocks of artificial alizarine, using bromine methods described in letters patent reissue No. 4321.

Dr. Glaser made:

I. Bibromanthrachinone from bibromanthracene, by conversion into bibromanthracentetrabromide into tetrabromanthracene, and oxidation of this latter into bibromanthrachinone; the oxidation was effected with nitric acid.

That Dr. Glaser informed deponent that this method is *industrially workable* without difficulty.

II. Bibromanthrachinone from bichloranthracene, by conversion into bichloranthracentetrabromide into bichlorbibromanthracene, and oxidation of this latter with nitric acid into bibromantrachinone.

That Dr. Glaser informed deponent that complainant was then,

and had been from the beginning of the artificial alizarine industry, manufacturing and using bichloranthracene as a primary material in making some artificial alizarine.

That Dr. Glaser informed deponent that the process for manufacturing artificial alizarine according to method "II," and fusion with water and alkalies, could be carried out on any scale *without any technical difficulties whatsoever, and declared that this method for the manufacture of artificial alizarine is industrially as workable as the methods employed when using sulpho-acids of anthrachinone.*

III. Bibromanthrachinone from anthrachinone, by directly brominating anthrachinone in closed vessels.

That Dr. Glaser informed deponent that this method is also *industrially workable.*

That Dr. Glaser converted the bibromanthrachinone, which was prepared by him in the said three several manners above mentioned, and manufactured the same into the yellow flocks of artificial alizarine in the manner described in patent reissue No. 4321.

Dr. Glaser declared to deponent that this process is also very easy, and, with little care, a failure impossible.

That deponent was present while several of the above men-
324 tioned conversions were carried out to the end of the manufacture and the washings with water of the yellow flocks.

That Dr. Glaser and deponent had dyeings made with some of the yellow flocks thus obtained, on cotton cloth prepared for dyeing with preparations of madder, and the colors obtained thereby were put to the usual tests for trying the fastness of madder colors, which they withstood perfectly, and developed into beautiful rich scarlets, delicate pinks and violets.

Deponent further says, that while in Europe he had frequent conversations with Prof. Charles Graebe, one of the inventors named in said reissued patents, on the subject of said invention, and how the same was accomplished.

That Prof. Graebe informed deponent that he, in connection with Prof. Charles Lieberman, in the years 1867 and 1868, were trying to solve the problem of the chemical structure of the most influential coloring matter of madder; that for this purpose they took Pernod's commercial madder extract, and heated the same with zinc dust, in order to obtain the hydro-carbon from which it could theoretically be derived; that they found, after the operation was finished, a waxy substance which, on examination with the reactions described by Anderson and by Fritsche, correspond with the hydro-carbon called "anthracene." That after this discovery they tried to obtain anthracene, and made a great many applications for it to the coal-tar distillers in England and Germany, but that they could not find any because those applied to did not know the substance.

That this lack compelled them to make small quantities by synthesis; but that this mode for procuring some was so deficient that

they did not obtain sufficient to work with; that about eight months after their first discovery a friend of theirs, who came from England, handed to them a quantity of nearly a pound of hydro-carbon, which proved to be rich in anthracene; that it contained probably 40 per cent. of it; that on this quantity they began operating immediately. That at first they made anthrachinone by their *new* process described in their patents; that they operated on this anthrachinone with sulphuric acid in order to obtain sulpho-acid of anthrachinone, but failed to observe distinctly its formation; that supposing they could operate with greater certainty with bromine for the same purpose, they operated with bromine on the anthrachinone, in place of sulphuric acid, and obtained brominated anthrachinone. That Prof. Graebe informed deponent that he took a little of the brominated anthrachinone and placed it, together with certain proportions of water and alkalies, into a tube glass, held the tube glass over a gas flame for heating the mixture, and, while so doing, observed a reaction taking place; that the tube glass proved to be a very suitable vessel
for the purpose, for, while the reaction was going on, some
325 water evaporated which partly condensed at the upper end of the glass, and ran down again on its sides, and on touching the mass it dissolved some of it, and a violet solution appeared; that when Prof. Graebe considered the reaction complete, he threw the whole mass into water and it dissolved with a violet color; that he filtered the violet solution and digested it with an acid, and obtained yellow flocks which he washed with water.

That Prof. Graebe informed deponent that he and Prof. Liebermann immediately commenced to dye cotton cloth prepared for dyeing with preparations of madder, *first*, with the yellow flocks obtained by their operation, and also, *second*, with Pernod's commercial madder extracts; that the colors obtained thereby were put to the usual tests for trying the fastness of madder colors; that the colors obtained on both pieces of cloth withstood the test satisfactorily, and developed with the characteristic properties of madder colors, that is, the alumina mordants developed with a red color and the iron mordants with a purple color, and both were fast against soaping.

Deponent further says that he is familiar with Pernod's commercial madder extract; that he was an agent for the sale of the same in this country prior to 1871, and for more than one year, and sold considerable quantities of it to calico printers; that this madder extract is a composition of the various coloring matters contained in madder root.

Prof. Graebe informed deponent that they never compared the colors obtained with their yellow flocks, with colors obtainable with chemically pure madder alizarine corresponding to the formula $C_{14} H_8 O_4$.

Prof. Graebe informed deponent that he never separated chemically pure alizarine from madder or madder preparations, and that by theoretical reasoning only they laid down the formula for madder alizarine, and never made an analysis of the same.

Prof. Graebe informed deponent that they never considered their yellow flocks to be chemically pure alizarine only, but saw very plainly that it was composed of many substances; that they were of opinion that *purpurine was amongst them*, and in order to ascertain whether this was a fact they sent some of their yellow flocks to Hugo Mueller, in London, to have it tested with the spectroscope by Prof. Stokes; that a good while after this, they were informed that Prof. Stokes could not detect purpurine in their yellow flocks.

Deponent directed the attention of Prof. Graebe to the following sentence of the provisional specification of their English patent, A. D. 1868, 18th December, No. 3850: "The alizarine prepared in this artificial way is perfectly pure and can be employed in all the applications to which the different preparations of madder are used," and asked Prof. Graebe what they meant by that? To which Prof. Graebe replied: "*That they meant a pure dyestuff, perfectly pure from injurious matters.*"

326 Deponent then asked him: "Then you did not mean chemically pure alizarine corresponding to the formula $C_{14}H_8O_4$?" To which Prof. Graebe replied: "Not by any means." Prof. Graebe further said: "Artificial dyestuffs are purer than preparations of natural dyestuffs. It was well known to us that commercial preparations of madder contained more or less impurities injurious in dyeing and printing with them, from which ours of necessity was perfectly free, and also free from acids, alkalies, and other matters which would have an injurious effect. The sentence in the provisional specification implies that it was pure for the employment in place of preparations of madder."

Deponent also directed Prof. Graebe's attention to their (Graebe and Liebermann's) essay on artificial alizarine, contained in the official report on the Vienna Exhibition, in the year 1873.

1. To the equations on p. 8, and asked whether they meant to express there that the result of the reaction consisted only of

$$\underset{\text{Alizarine.}}{C_{14}H_6(OH)_2(O_2)''} + 2\,K\,Br.$$

To which Prof. Graebe replied in substance:

"Not by any means. We expressed there, as is the practice, simply that part of the reaction which was under consideration, without including *by-products* in the equations. It must not be supposed that we meant to convey the idea that no by-products were present."

2. To where they use, on page 9, the word "alizarine," whether they meant there chemically pure alizarine, $C_{14}H_8O_4$?"

To which he replied:

"No, we meant the dyestuff, and that it would have been a better expression to have used in place of the word 'alizarine' the word 'dyestuff.'"

3. To where they say, on p. 11, that they originally had tried to obtain anthrachinone-sulpho-acids. Why they did not investigate that more fully?

To which Prof. Graebe answered in substance:

327 "Having so little raw material, we operated of necessity on small quantities. We used tube glasses, holding them over gas flames, by which, of course, the heat could be little regulated, consequently a variety of reactions took place which prevented our observing distinctly the formation of sulpho-acids of anthrachinone. We were, at the time, pretty sure of its formation, but we could not separate it from the other products of the reaction, the quantity being so small, and therefore could not say so with certainty. I have with the experience acquired since that time, no doubt whavever that some had been formed. Supposing we could obtain the desired result with greater certainty with bromine, and being anxious to waste as little material with experiments as possible, we used bromine in place of sulphuric acid, and obtained immediately the desired result. When we had obtained the dyestuff, we did not for the time being make further investigations with sulphuric acid, but when, in April, 1869, Dr. Caro came to us as an agent of the Badische Anilin and Soda Fabrik to negotiate with us about obtaining our patent rights of this invention, myself and Liebermann immediately told him and explained to him our working with sulphuric acid, and we three together spoke then, in Berlin, and also afterwards, about the use of the same for manufacturing purposes. After negotiations were concluded with the Badische Anilin and Soda Fabrik, Dr. Caro returned to the factory, and I followed him a few days after for the purpose of putting our invention into practical operation. As soon as we began work there, we commenced also to experiment in the laboratory of the company with sulphuric acid. It was the duty of Dr. Caro, as chemist of the company, to attend to the experiments while I was engaged in the factory. I called, of course, constantly at the laboratory while the experiments were being carried out to observe and consult about their progress. One morning Dr. Caro observed a reaction taking place, and while it was going on observed the formation of sulpho-acid of anthrachinone; as soon as it was finished, Dr. Caro brought the result immediately to me, into the factory. As soon as this result was obtained, we ceased using bromine for the manufacture."

4. To where they say, on p. 10, "The above methods which are at present only of historical interest for industrial (technical) purposes"—what they meant by that?

328 To which Prof. Graebe answered in substance:

"That they meant the application of bromine in the methods described above. That they did not mean their new method for producing anthrachinone, as they very plainly said so on page 8, where they say its history and production would be described fully further on. (Pp. 18 to 22.) That they did not mean either the conversion of anthrachinone, and that they surely did not mean the process of fusing the converted anthrachinones with water and alkalies into a dye-stuff. That all of these methods, from the first con-

version of anthracene to the finished dye-stuff, have been and are in practical use since the beginning of the artificial alizarine industry until now."

5. To where they say, on p. 27: "Auerbach, who made the first communication on it, called it isopurpurine. Perkin, to whom we are indebted for an exhaustive investigation on it, called it anthrapurpurine," and asked why they gave Auerbach the priority, and whether they had read the original publications of Perkin on the subject?

To which Prof. Graebe answered in substance:

"That he had not seen or read the original publications of Perkin.

"That he had only seen—

"1st. The publication of Auerbach in the Moniteur Scient., 1872, p. 686.

"2d. The translations of Perkin from the Journal of the Chemical Society, vol. XI, p. 425, in the Moniteur Scient., 1873, p. 788, and in Journ. f. prakt. Chem., vol. VIII, p. 241 (1873); and as Auerbach's publication dated prior to the translations of the publication of Perkin, they gave Auerbach the priority by courtesy. That he had not seen Perkin's original communications on the subject published in the Journals of the Chemical Society of 1870 and 1872. It will be noticed, however, that we mention in our essay, on page 27, that Auerbach made only a communication, and that Perkin published an exhaustive investigation on it. We always considered the investigation of Auerbach as an imperfect one; recent investigations have proved that we were correct."

And deponent further says, that while in Europe a copy of an affidavit of Gustav Auerbach, dated Barmen, 25th of March,
329 1878, filed in a suit of these complainants against T. K. Cummins; also a copy of an affidavit of Carl Otto Neuhaus, dated Elberfeld, 6th April, 1878, filed in the same suit; also a copy of an affidavit of Carl Rumpff, dated Glasgow, 5th April, 1878, also filed in the same suit, were handed to him; that he read said affidavits of Auerbach, Neuhaus, and Rumpff, and found that they state or imply in substance, among other things, that in manufacturing artificial alizarine from anthracene the manufacturer can and does produce chemically pure alizarine only, corresponding to the formula C_{14} H_8 O_4, as the result of an operation, without any isomeric purpurines, or other matters or substances resulting in the melt.

That after reading said affidavits deponent, in order to ascertain whether those statements were correct, made inquiries of—

Dr. August Clemm, principal technical director;

Dr. Heinrich Caro, head chemist of the laboratory;

Dr. Charles Glaser, superintendent of the artificial alizarine department;

Dr. Ernst Brunck, associate superintendent of the artificial alizarine department,

Of the Badische Anilin and Soda Fabrik,

and asked each separately, and without explaining the reason why

the inquiry was made, and without letting any of them know that similar inquiries had been or would be made of any of the gentlemen named:

"Is it possible, in the manufacture of artificial alizarine, to make a melt or operation which will consist of chemically pure alizarine, corresponding to the formula $C_{14}H_8O_4$ only, without producing in the same operation isomeric purpurines?"

To which all of them answered in substance:

"It is impossible. There is not, and never has been, an artificial alizarine produced and offered in the market, which does not contain, in smaller or greater quantities, isomeric purpurines"

After having received the answers from these gentlemen separately, deponent informed them of the object he had in asking the question, and inquired of them the status of Auerbach as a manufacturer and chemist, to which each answered, in substance, that as a manufacturer he was considered of little account, and as chemist as a very careless investigator and writer, who made assertions loosely; that he was then employed in a factory with which Carl Rumpff is connected.

Deponent further says that he has read an article in the Moniteur Scientifique, 3 serie, tome VIII, October, 1878, on p. 1118, "On the Preparation of Pure Alizarine," by Auerbach.

330 And that in this article Auerbach states that isopurpurine is always produced together with alizarine.

Deponent further says that he knows, personally, Carl Otto Neuhaus, and knows that he and his brothers, and probably other parties, form the firm of Carl Neuhaus; that they used to be dealers in madder and madder preparations; that after artificial alizarine became an important competitor of the article in which they dealt, they engaged in manufacturing artificial alizarine; that Carl Otto Neuhaus is neither a chemist nor a scientist. That deponent is informed and believes that Carl Otto Neuhaus is interested with Thomas K. Cummins, defendant in the suit in which said affidavit of Neuhaus is made, in the result of the said suit; that the artificial alizarine which said Cummins is selling in violation of complainants' patent, is manufactured and shipped by the firm of Carl Neuhaus.

Deponent further says that he made the acquaintance of Carl Rumpff in this country, in the year 1864 or 1865, when he was selling aniline colors for a German firm, and has seen him since from time to time; that said Rumpff has latterly been associated with his father-in-law, who is a manufacturer of aniline colors and artificial alizarine; that Carl Rumpff is neither a chemist nor a scientist; that in the year 1875 Carl Rumpff visited the United States for a short time for the special purpose of selling artificial alizarine, which he did in violation of complainant's patent, and that he then applied to deponent's firm to obtain a license from complainant to sell artificial alizarine under complainant's patent; that Carl Rumpff is a party to this suit.

And deponent further says: That he has read the affidavit of

Charles F. Chandler, dated April 24, 1878, made by him in the suit of these complainants against T. K. Cummins, in the United States circuit court, district of Massachusetts, and finds there the following:

"I testified in the suit of Badische Anilin und Soda Fabrik *vs.* James Higgins and others, in the southern district of New York, being called as an expert for the defendants; and preparatory to giving that testimony, I made a very extensive examination of the chemical literature relating to natural and artificial alizarine, and their application in dyeing and calico-printing. In the suit of Higgin, I was examined before Prof. Morton was called as a witness, and the question whether artificial alizarine was a new composition was never presented to me. I have never until now had occasion to discuss the testimony of Prof. Morton."

I find in the direct testimony of Prof. Chandler, in the Higgin suit, in answer to

331 "Q. 6. What are all the sources from which alizarine is obtained, so far as you know?

"A. Alizarine is obtained:

"First—From the madder root, as already described. * *

"Second—From mungeet. * * *

"Third—From a plant called mornia citri-folia. * * *

"Fourth—From anthracine.

"Q. 8. How is alizarine made from anthracene—state fully and particularly?

"A. Anthracine is a hydro-carbon, having the composition C_{14} H_{10} * * * * * * * *

To convert anthracine into alizarine it is necessary

* * * * * * * *

this change of anthracene to alizarine may be effected in various ways:

"1. Graebe and Liebermann first discovered that a relation existed between alizarine and anthracine, by obtaining anthracine from alizarine by heating it with zinc-dust. They prepared alizarine from anthracine by first replacing H_2 by O_2, and producing anthraquinone C_{14} H_8 O_2. In this body they replaced H_2 by Br_2 by treating the anthraquinone with bromine, and producing bibromanthraquinone C_{14} H_6 Br_2 O_2. They then replaced the bromine by hydroxyl by heating with potassic hydrate K O H, producing potassic alizarate C_{14} H_6 $(K\ O)_2$ O_2. By decomposing this with an acid, as hydro-chloric, they substituted hydrogen for potassium, and produced alizarine, C_{14} H_6 $(O\ H)_2$ O_2."

Then follow the descriptions of seven other methods, and ending with the following paragraph:

"Purpurine differs from alizarine in having three hydrogen atoms replaced by hydroxyl instead of two, and it is found that the processes that I have mentioned, as devised by different chemists, for the preparation of alizarine from anthracene result in the formation of some purpurine; derived from this source, the name anthrapurpurine has been given.

the inquiry was made, and without letting any of them know that similar inquiries had been or would be made of any of the gentlemen named:

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"Purpurine differs from alizarine in having three hydrogen atoms replaced by hydroxyl instead of two, and it is found that the processes that I have mentioned, as devised by different chemists, for the preparation of alizarine from anthracene result in the formation of some purpurine; derived from this source, the name anthrapurpurine has been given.

"Q. 18. What are the impurities in alizarine extracted from coal-tar, or artificial alizarine?

"A. The impurities in artificial alizarine are anthracene, anthraquinone, oxyanthraquinone, anthraflavic acid, anthrapurpurine, a yellow compound which dyes cotton mordanted with alumina of an orange tint; other yellow bodies, the nature of which has
332 not been determined, and the dioxyquinone of chrysene, besides sulphates or chlorides of potassium or sodium.

"Q. 19. You have stated in your previous testimony, in substance, that the doubts heretofore entertained concerning the identity of alizarine from madder and coal-tar alizarine, or artificial alizarine, had disappeared; on what do you base this statement, and what authorities, if any, can you give on this point?

"A. I base this statement on the fact that the earlier experimentors who compared alizarine from anthracene, with alizarine from madder, operated, in many cases, upon impure materials. The alizarine from anthracene, which they employed, was contaminated with the impurities I have just mentioned, which caused certain differences in the results obtained on exposing it to the various tests necessary to prove its identity with the alizarine from madder. As the nature of these impurities has been ascertained, and methods have been devised for purifying the alizarine from anthracene, the results of the comparative tests have been found to be identical.

"x-q. 154. Is the artificial alizarine, referred to by you in your answer 18, of the composition represented by the chemical formula $C_{14} H_8 O_4$?

"A. Not by this formula alone. It consists chiefly of alizarine, having the composition exhibited by this formula, but it contains in addition variable proportions of the impurities which I mentioned in my answer to question 18.

"x-q. 155. Then, as a composition of matter, the artificial alizarine, of which you speak in your answer 18, is not a composition represented by that formula, is it?

"A. Not if you count in the non-essential impurities, any more than it is in the case of alizarine in its commercial forms, as obtained from madder. A chemical formula is necessarily limited to a single definite compound. The alizarine, whether extracted from madder, or prepared from anthracene, is a definite compound of a composition represented by the formula $C_{14} H_8 O_4$, and each impurity which may happen to be associated with it, no matter what its source, is also a definite compound, and has its own definite formula which is not included in the formula of the alizarine, and no formula can be given for a mixture.

"x-q. 156. Do any of the things which, in your answer 18, you call impurities in artificial alizarine, act as dyes or coloring matters?

333 "A. It is said by Perkin, though I never have confirmed his statement, that anthrapurpurine produces colors with mordants analogous to those produced by alizarine—reds with alumina,

purple and black with iron; there being, however, slight differences in the shades produced by the two dyes.

"x-q. 157. What is the chemical formula which represents anthrapurpurine?

"A. According to Perkin it is $C_{14}H_8O_5$.

"x-q. 158. Are these things which, in your answer 18, you have mentioned as impurities in artificial alizarine, found in any of the preparations from madder which you have mentioned in your answer to question 4?

"A. They have never been reported by any chemist as occurring there.

"x-q. 159. Are they found in any other preparations or extracts from madder?

"A. Not to my knowledge."

Deponent further says that on October 14, 1876, when Prof. Morton was examined by Mr. G. M. Plympton, counsel for defendants in the Higgin suit, Prof. Charles F. Chandler was present, and aided counsel for defendants in the examination.

Further, that on October 21, 1876, when Prof. Morton was again examined by Mr. G. M. Plympton, Prof. Chandler was again present, and aided counsel for defendants in the examination; the first question asked on that day was:

"x-q. 131. Will you oblige me by stating all the substances, as well as the elements, that are found in artificial alizarine, also in madder alizarine, so far as they are within your knowledge; I mean the commercial alizarine of both kinds?

"A. *Artificial alizarine.*

"Chemically pure alizarine of the formula $C_{14}H_8O_4$.

"Monoxanthrachinone of the formula $C_{14}H_8O_3$.

"Anthraflavic acid, having the same formula as alizarine, but totally unlike it, having no tinctorial properties whatever.

"Isoanthraflavic acid, also having the same formula as alizarine, but differing from it by having no tinctorial properties, and being distinguished from anthraflavic acid by certain reactions.

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"ANTHRAPURPURINE, having the formula $C_{14}H_8O_5$; in other words, isomeric with purpurine, and having likewise tinctorial properties which are, however, entirely different from those of purpurine.

"*Madder alizarine.*

"Chemically pure alizarine of the formula $C_{14}H_8O_4$.

"Pseudopurpurine, whose formula is $C_{14}H_8O_6$, a substance which possesses strong tinctorial properties, producing rich colors with the usual mordants, which, however, wash out with clearing and soaping.

"Hydrate of purpurine, which yields tolerably fast colors with mordants after the action of boiling soap.

"XANTHROPURPURINE, whose composition is $C_{14}H_8O_4$, which does not possess tinctorial properties.

"PURPURINE, whose formula is $C_{14}H_8O_5$, the same as that of anthrapurpurine and isopurpurine, and which, like them, produces

"ISOPURPURINE, having the same formula, and having also tinctorial properties which are, however, quite distinct from either those of purpurine or anthrapurpurine.

"FLAVOPURPURINE, a body having the same formula as the above, but distinguished from it by certain reactions, and especially by its absorption spectrum.

"PERKIN'S ORANGE MATTER, which has not yet been analyzed.

"ANTHRACHINONE.

"ANTHRACENE, and various mineral and other accidental impurities, such as soda.

colors with alumina and iron mordants, but of shades readily distinguishable and much less fast or resistant to washing with soap.

"GREATER OR LESS QUANTITIES of wood fibre and various practically unimportant organic or inorganic compounds, such as glucose, cane sugar, gum, mucilage, albumen, erythroxyn, pectin, pectic acid in combination, chlorogenin, citrates, malates, taltrates, oxyilates, sulphates, phosphates, chlorides, potassium salts, sodium salts, calcium salts, and magnesium salts.

"The presence or quantity of these unimportant substances depending upon the character of the commercial alizarine considered, the purer forms having, no doubt, only traces of some, and no appreciable quantities of others.

"In the above lists I have given all the substances which I can at this time recall.

335 "I should also remark that all of the important substances named would not be found in all the madder alizarines. Thus pseudopurpurine, being decomposed by a high temperature or converted into purpurine and xanthropurpurine, would not be found in a madder extract which had been highly heated."

Deponent finds further in the affidavit of Prof. Chandler:

"Their process, however, never passed beyond the limits of experiment, as it was not practicable on a large scale, and they were soon obliged to give up their Prussian patent because they were not able to prove that their process was in practical operation.

"The process which forms the basis of the industry of to-day was invented first by Henrich Caro in 1869, and an English patent for that process was taken out by him in association with Graebe and Liebermann in that year." * * * * *

"This sulpho-acid process invented by Caro is not a simple equivalent for the process invented by Graebe and Liebermann, in which bromine and chlorine were employed.

"The conditions of temperature under which these sulpho-acid processes are practicable were not known to chemists at that time, and were discovered by investigation and experiment by Caro. These conditions of temperature were incompatible with what Graebe and Liebermann believed to be the properties of anthrachinone.

"These facts are so well known that Dr. Reimann, editor of Farber

Zeitung, published in Berlin, and of the Journal de Teigture, which is the French edition of the same, made the following statement in his article 'Farberei,' in Muspratt's 'Theoretische Practische Analytische Chemie,' 2d vol, p. 1125, Brunswick, 1874." * *

"In speaking of the Graebe and Liebermann process Reimann says: 'This method of preparation possesses only a purely theoretical interest. Graebe and Liebermann had so little success in manufacturing alizarine on a large scale by this process that they were soon obliged to give up the Prussian patent granted them, because the inventors were unable to prove that their process was in practical operation. The methods practically employed in the manufacture of artificial alizarine did not originate in the first place with Graebe and Liebermann.'"

Deponent says the statements in this foot-note are not accurate.

1. In reference to the Prussian patent.

336 2. In reference to the inventors of the process now usually applied for the manufacture of artificial alizarine.

1*a*. In reference to the Prussian patents:

Graebe and Liebermann had granted to them from the Prussian government only protection of patent rights for the period from the 23d March, 1869, to the beginning of July, 1870, and that had only a bearing in the kingdom of Prussia; but that the factories of complainant, where Prof. Graebe was carrying out practically the methods of their invention, during the time from the beginning of May, 1869, to on or about the 12th of June, 1869, when he ceased working with bromine, and substituted sulphuric acid for the same purpose, were not located in the kingdom of Prussia, but in the kingdom of Bavaria.

Deponent has copies of the Prussian patent and its revocation before him, and he herewith gives translations of parts of them:

"BERLIN, 23d March, 1869.

"PATENT for Dr. Carl Liebermann and Dr. Carl Graebe, at Berlin, for a process of industrially producing a red dyestuff from anthracene.

"IV 3790.

"With the highest sanction of his majesty the king, I grant herewith a patent to Dr. Carl Liebermann and Dr. Carl Graebe, at Berlin, according to their application, for a process of industrially producing a red dyestuff from anthracene. This patent is valid for the term of five consecutive years from to-day, under the condition that the receivers of it fulfill strictly the conditions of the proclamation of the 14th October, 1815, in reference to the granting of patents, with the exception of § 5, about publication, as this will be done by the department.

"Particularly must the application of the patented process be in practical operation within twelve months from the date of this patent, within (innerhalb) the kingdom of Prussia, and this must be

proved by legal certificate, otherwise the rights granted through this patent will be revoked."

* * * * * * * *

"THE MINISTER FOR DEPARTMENT OF COMMERCE, INDUSTRY AND PUBLIC WORKS."

337 *Notice to Comply with the Conditions of the Patent.*

"BERLIN, 2d June, 1870.

"With referenc to the directions of the 10th February, 1870, and 13th May, this year, you are hereby requested to furnish the proof of the carrying out of the patented process of the 23d March of last year, for the process of industrially producing a red dyestuff from anthracene within four weeks at latest, in default of which the patent will be cancelled immediately.

"DEPARTMENT OF COMMERCE, INDUSTRY AND PUBLIC WORKS.

"To Messrs. Dr. Carl Liebermann and Dr. Carl Graebe."

Revocation.

"BERLIN, 7th July, 1870.

"The patent given you on the 23d March of last year, for a process of industrially producing a red dyestuff from anthracene, has been declared extinct, because you have not brought proof of the carrying out of the patented methods within the prescribed time and within the four weeks granted you on the 2d of June.

"DEPARTMENT OF COMMERCE, INDUSTRY AND PUBLIC WORKS.

"To Messrs. Dr. Carl Liebermann and Dr. Carl Graebe."

2*a*. In reference to Reimann's statement about "the inventors of the process now usually applied for the manufacture of artificial alizarine," Dr. Reimann describes in the article itself, of which Prof. Chandler quotes only a foot-note, various methods of manufacturing artificial alizarine, and makes certain comments upon them, of which deponent renders herewith translations of parts of them bearing on the subject, pp. 1125 to 1127, also of the foot-note:

"In 1868 Graebe and Liebermann really succeeded to obtain alizarine from anthracene. * * *

"The process by which Graebe and Liebermann produced alizarine is, according to the description of the patent, as follows:*

*"This process for producing has only a theoretical interest. Graebe and Liebermann attained so little progress in producing alizarine in large quantities that the Prussian patent granted them had soon to be dissolved because the inventors were unable to produce evidence of the carrying out their method in practice. Amongst the inventors of the process now usually applied for the manufacture of artificial alizarine, Graebe and Liebermann do not stand first in the line."

338 "1. Anthracene (C_{14} H_{10}) is to be converted into anthrachinone (C_{14} H_8 O_2)." * * * *

[Then follows the description of the process, and then follows:]

"The production of artificial alizarine on a large scale was found the more difficult, besides the more troublesome process just described, on account of the scarcity of anthracene obtainable. It is, therefore, a merit of Broenner and Gutzkow to have found in asphaltum a rich source for the raw material of the artificial madder dyestuff. * * *

"The first method of Graebe and Liebermann was not suitable for producing large quantities of alizarine. * * * *

"It was the process of the application of sulphuric acid compounds which made a production of alizarine on a large scale possible.

"On the 27th May, 1869, Broenner and Gutzkow took a patent for the manufacture of artificial alizarine. According to this, anthracene is oxydized with its double weight of nitric acid of 1.5 specific gravity to anthraquinone, after purification heated with sulphuric acid, after which nitrate of mercury is to be added. The compound obtained thereby has to be dissolved in caustic alkalies, filtrated, and the solution precipitated by acids. * * * *

"At about the same time, Graebe and Liebermann, also Perkin, had studied the reaction of sulphuric acid on anthraquinone; Graebe, Liebermann and Caro took out an English patent for such a process on the 25th June, 1869; Perkin also took out one only one day later. But it seems that Perkin thoroughly knew the important reaction of sulphuric acid earlier than Graebe and Liebermann."

* * * * *

"In the meantime Graebe, Liebermann and Caro had made a further important step in the simplification of the manufacturing methods, evading entirely the production of anthraquinone."

"It is a fact, beyond doubt, that in the production of artificial alizarine purpurine is *always* formed besides alizarine; *how this formation takes place is not known up to this time*, but so much is certain that, according to the one or the other process applied, as well as to the *manner in which it is directed*, a *larger or smaller* quantity of purpurine is *obtained*.

339 "An alizarine containing a large quantity of purpurine will always be *preferred* to an alizarine containing little or no purpurine, because the compound of *both* dyestuffs *only yields all colors in brilliant and entirely solid—fast—shades*." (The italics are deponent's.)

The deponent further says, regarding the statements of Prof. Chandler quoted above, that he has a copy of an application of Graebe and Liebermann to the Prussian Government for a patent for an *Improved Process for producing a Red Dyestuff from Anthracene*, and the answer thereto from the Prussian Government, of which deponent has copies, and he herewith gives translations of the same:

"To the Minister of Commerce, Industry and Public Works, His Excellency Count von Itzenplitz:

"Your Excellency is prayed by the undersigned for the granting of a patent, as described below, for an *Improved Process for Producing a Red Dyestuff from Anthracene.* This new method is the necessary development of our method for producing the red dyestuff from anthracene, for which your Excellency granted us the protection of patent rights on the 23d March of this year. Since then it has been a question with us to substitute for the disagreeable bromine in the manufacture a more convenient re-agent. In this we have been entirely successful, through the below described method.

* * * * * * *

"BERLIN, 27th August, 1869.

"(Signed) DR. CARL GRAEBE.
" DR. C. LIEBERMANN."

BERLIN, 21*st September*, 1869.

"On the examination of your application of the 27th of last month for a patent for a process for manufacturing alizarine, it was found that the process in question only differs from the one patented by you on the 23d of March of the present year, and which has meanwhile become known by communications in periodicals, by substituting for the anthrachinon derivatives formerly used, another one. In the patented process the production of a red pigment from the chlorine or bromine anthrachinone was effected by their reaction on alkali; in the process submitted in this instance, from anthrachinone
340 sulpho-acid, also by action of alkali. This modification of the known process cannot be looked upon as an invention, as would justify the granting of a patent.

"The application has, therefore, to be refused, and the description presented is returned herewith.

"DEPARTMENT FOR COMMERCE, INDUSTRY, AND PUBLIC WORKS.

"To Messrs. Dr. C. GRAEBE and Dr. LIEBERMANN."

Deponent finds further in the affidavit of Prof. Chandler:

"In their report at the Vienna exhibition, in which they gave a history of their invention, they make the following statement:

"The following equations represent the reactions which first give anthrachinone from anthracene, then bibromanthrachinone, and finally alizarine:

I. $C_{14}H_{10}+3O = C_{14}H_8(O)_2''+H_2O.$
Anthracene. Anthrachinone.

II. $C_{14}H_8(O_2)''+4\,Br = C_{14}H_6Br_2(O_2)+2\,BrH.$
Bibromanthrachinone.

III. $C_{14}H_6Br_2(O_2)''+2KOH = C_{14}H_6(OH)_2(O_2)''+2KBr.$
Alizarine.

And says that what Prof. Chandler termed above:

"Their report at the Vienna exhibition, in which they gave a history of their invention,"
is entitled by Graebe and Libermann, and begins as follows:

"*Historical Development of the Alizarine Synthesis.*

"The discovery of artificial alizarine resulted from investigations made by Graebe and Libermann for obtaining a more thorough knowledge of the chemical structure of the most influential coloring matter of the madder roof, that is, for solving a purely scientific problem."

* * * * *

And the paragraph quoted by Prof. Chandler, and the one prior to the quotation, read:

341 "Scientifically, Graebe and Liebermann had hereby solved the problem of the alizarine synthesis, and by that found considerable aid for their opinion which led them from the beginning, in reference to this coloring matter.

"The following equations *exhibit* the reactions which first *led* from anthracene to anthrachinone, then from this to bibromanthrachinone, and ultimately to alizarine:

I. $C_{14}H_{10} + 3O = C_{14}H_8(O_2)'' + H_2O$.
Anthracen. Anthrachinon.

II. $C_{14}H_8(O_2)'' + 4Br = C_{14}H_6Br_2(O_2)'' + 2BrH$.
Bibromanthrachinon.

III. $C_{14}H_6Br_2(O_2)'' + 2KOH = C_{14}H_6(OH)_2(O_2)'' + 2KBr$.
Alizarin.

Deponent further says that the statements of Prof. Graebe, embodied in this affidavit, give further explanations regarding the statements of Prof. Chandler, and deponent furnishes herewith a copy of a part of a letter of Prof. Charles Liebermann, one of the inventors named in said reissued patent No. 4,321.

"BERLIN, 16, 11, 75.

"*Badische Anilin and Sodafabrik at Ludwigshafen.*

"By the fusion of bibromanthrachinon (from anthraquinon) and potassa, anthra or isopurpurine are certainly formed, although not in exactly considerable quantities; to prove it, I followed the directions of Perkin for anthrapurpurine. The coloring matter resulting from the fusion, and which has been precipitated and washed, is treated with a solution of soda and shaken with freshly precipitated (and washed) hydrate of alumina. On filtering, the purpurine goes into solution; what was in solution was again precipitated and treated in the same manner, and this repeated several times. After thus treating it three times its quantity was considerably lessened, but there was still isopurpurine present. That the dyestuff obtained from bibromanthraquinone contains isopurpurine is also shown by the enclosed swatches dyed with the (thoroughly washed) raw product." * * * * *

"Respectfully,
("Signed) LIEBERMANN."

That deponent has caused to be made in his presence the fusion or melt of bibromanthrachinone with water and alkalies, according to the directions of the patent, at least ten times, and by different chemists, and the result of each operation was not chemically
342 pure alizarine, but a composition of various coloring matters. With some of the results of each operation deponent had dyeing tests made, some of which are in evidence in this case, the Hamilton Manufacturing Co. case, and in the Higgin case, and each of the tests prove that isomeric purpurines are always produced in the reaction or melt of bibromanthrachinone with water and alkalies.

Deponent says that he has seen many dyeing tests—at least fifty—made with artificial alizarine produced by bromine methods, and made by different chemists, according to the directions of the patent, and found that all and each of these tests proved the presence of isomeric purpurines in the product.

Deponent further says that he is informed and believes that Prof. Charles F. Chandler was retained and employed as a chemical expert for the defendants in this suit; that when the motion for preliminary injunction in this case was made and came up for hearing before his Honor Judge Blatchford, in July, 1875, a lengthy affidavit of Prof. Chandler was read by counsel for defendants.

Deponent further says that he has read the petition and affidavit of Alexander Cochrane, for a rehearing of this case, and finds therein the following statement:

"A motion for injunction was made in this court against me, and was, as I am informed and believe, argued by the counsel for the complainant on the one side and decided by the court without calling upon my counsel, on the ground that the reissued letters patent were void on their face."

To which deponent replies: That he was present in court and heard George Gifford, esq., counsel for complainant, and E. N. Dickerson, esq., one of the counsel for defendants, argue said motion before his Honor Judge Blatchford; and that Mr. Beaman, the other counsel for defendant, also took part in the argument; and that deponent heard the remarks made by his Honor Judge Blatchford; that his honor stated in substance that as the case seemed to be a complicated one he did not feel justified in granting the motion on so limited a knowledge of the facts, and advised counsel to proceed with the case in the regular way, and that his opinion should not be understood to prejudge the case.

Deponent further says that Prof. Morton completed his direct testimony for complainant in this case on the 9th day of October, 1876, and that the examination of Prof. Morton by defendant's counsel was taken on November 16th, 1876, and adjourned. That on the 22d of December, 1876, counsel for defendant waived further cross-examination. That deponent was informed and believed that
343 defendants intended to introduce testimony, and a stipulation dated November 11, 1876, was made between counsel for both parties "that the defendants shall have until February 1st,

1877, to put in their testimony in reply" (see p. 56*b* Compl't's Record); and that on the 31st of January, 1877, another agreement was signed by counsel for complainant and by counsel for defendants, extending the time for putting in testimony for the defendants until the 15th of February, 1877.

Deponent further says that he has read a pamphlet entitled "Profs. Graebe and Liebermann on Artificial Alizarine;" that the translations contained therein, from the German into English, are imperfect; that all the publications quoted therein were in this country long prior to the commencement of this suit, except Graebe and Liebermann's Essay on Artificial Alizarine, contained in the official report on the Vienna exhibition in the year 1873, of which printed copies were in this country in the early part of 1876, and quotations were made from it as well as from the other publications in the testimony in this case, and in the Hamilton Manufacturing Co. case, and in the Higgins case, in the same year, 1876.

Deponent further says that Prof. Chandler quoted from most of these publications in his affidavit read at the hearing of the motion for preliminary injunction in this case, in July, 1875.

And deponent further says that he is informed and believes that the suit of this complainant against the Hamilton Manufacturing Co., in the Massachusetts district, and which was decided by the late Judge Shepley, was defended by the defendants in this suit and at their expense.

Deponent further says that he has read the affidavits filed in behalf of the defendant in the suit of this complainant against T. K. Cummins, of

William Bogle,
James Threlfall,
Samuel W. Johnson,
Albert Horton,
John Bracewell,
Robert Henry,
Henry Burrows,
Thomas Walsh,
James Hunter,

and states that he is and has been for many years well acquainted with said

Albert Horton,
John Bracewell,
Robert Henry,
Henry Burrows,
James Hunter,

and has frequently visited the print works with which they
344 are respectively connected; that they informed deponent on many occasions in substance:

I. That the greatest part of the calicoes which were made in

their respective print works were the so-called "madder prints;" that for this purpose they used chiefly madder or a preparation of madder called garacine;

II. That for some purposes they could *not* use artificial alizarine in place of madder or garancine;

III. That for some purposes they used a mixture of artificial alizarine and garancine;

IV. That for some purposes they used artificial alizarine alone for obtaining results which they could not obtain with preparations of madder.

And deponent further says, that for the print works with which the gentlemen who gave the aforementioned affidavits are connected, many purchases of artificial alizarine have been made from its introduction until the present time; and that during that time madder and preparations of madder have also been used by them, as deponent has been informed.

Deponent further says that in answer to inquiries addressed to Messrs. Walter Crum & Co., of Glasgow, the following letter was received:

"THORNLIEBANK, GLASGOW, 21 *June*, 1878.

"*Messrs. The Badische Anilin and Soda Fobrik:*

"GENTLEMEN—In answer to your letter of the 7th June, we are very glad to bear testimony to the immense advantages which the industry of calico-printing has derived from the introduction of artificial alizarine.

"A few years previous to its becoming an article of commerce a considerable extension had been given to the means of printing permanent reds in combination with pigment or steam colors (blue, green, yellow, &c.), by the discovery of a preparation of madder known as "madder extract," and we imagine that it is therefore unnecessary to consider the state of the trade before the introduction of that substance, but rather to compare the colours obtained by its use with those now got with artificial alizarine.

"We have collected a few examples of the class of goods chiefly made here, which we hope will answer the purpose you have in view. Should you wish any others which it is in our power to fur-
345 nish, we hope you will not hesitate to inform us.

"No. 1. Reds produced by *madder* dyeing.

"No. 2. Reds produced by *artificial alizarine* (instead of madder) dyeing.

"No. 3. Reds combined with pigment or steam colors, printed without dyeing and fixed by steaming.—'*Madder extract.*'

"No. 4. Various styles, all containing more or less red, in combination with pigment or steam colors, printed without dyeing and fixed by steaming.—*Artf'l alizarine.*

"*First.* Comparing Nos. 1 and 2, it is evident that brighter, fuller, richer reds are obtained by substituting artificial alizarine for madder in the ordinary process of cotton dyeing. We say nothing of

the comparative cheapness of the alizarine reds now produced, as that is due more to the moderate price of the article itself than to any diminished expenditure of time or labor in their production; but it is undoubtedly the fact, that a degree of brilliancy is now obtainable which was formerly almost unknown.

"Next, with regard to Nos. 3 and 4, we may say, without going into technical details, that we are enabled, by the use of artificial alizarine applied topically, to produce combinations of colors and effects of design in infinite variety, which, even with 'madder extract,' we could not have attempted. A comparison of the reds in No. 3 with those in No. 4 A, will show the greatly superior brilliancy of the new product.

"Nos. 4, B, C, D, and E, are examples of styles of coloring which, before artificial alizarine was known, could only have been produced by the use of loose fugitive reds (such as cochineal) or (in the case of some of them) by dyeing with madder, and subsequently fitting the blue, green, &c., by hand printing, and at great additional cost.

"We are, gentlemen, yours faithfully,

"WALTER CRUM & CO."

And deponent further says, that he is familiar with the German and English languages.

WILHELM PICKHARDT.

Subscribed and sworn to before me this 18th day of November, 1878.

R. E. STILWELL,
U. S. Com'r for southern district of N. Y.

346 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

CITY AND COUNTY OF NEW YORK, SOUTHERN DISTRICT OF NEW YORK, *ss.*

HENRY MORTON, being duly sworn, deposes and says: I have read the affidavits of Prof. Charles F. Chandler, of April 24, 1878; Gustav Auerbach, of March 25, 1878; Carl Otto Neuhaus, of April 6, 1878; Carl Rumpff, of April 5, 1878, taken in the suit of these complainants against T. K. Cummins, and I have also read and am familiar with the letters patent, reissue No. 4321, on which this suit is brought, and believe I understand the invention described and made known therein; that I have frequently carried out the process described therein, and produced the yellow flocks of artificial alizazine which are the subject of said patent, and made dyeing and other tests with the same; and have also made dyeing and other tests with chemically pure alizarine made from madder, and with the various commercial preparations of madder and of artificial alizarine used in the arts of dyeing and calico printing; and in consequence

their respective print works were the so-called "madder prints;" that for this purpose they used chiefly madder or a preparation of madder called garacine;

II. That for some purposes they could *not* use artificial alizarine in place of madder or garancine;

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And deponent further says, that for the print works with which the gentlemen who gave the aforementioned affidavits are connected, many purchases of artificial alizarine have been made from its introduction until the present time; and that during that time madder and preparations of madder have also been used by them, as deponent has been informed.

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the comparative cheapness of the alizarine reds now produced, as that is due more to the moderate price of the article itself than to any diminished expenditure of time or labor in their production; but it is undoubtedly the fact, that a degree of brilliancy is now obtainable which was formerly almost unknown.

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of the knowledge and experience thus obtained I assert empthatically that in so far as the above mentioned affidavits assert or may be construed as asserting that the yellow flocks of artificial alizarine prepared according to the description of complainants' patent are essentially or practically identical with chemically pure alizarine or any extract of madder, they are not true and do not express the facts of the case. On the contrary, I find that when the process described in said patent is literally and accurately carried out, the product obtained as yellow flocks does not consist of chemically pure alizarine, either alone or in combination with any other constituent found in madder-root, but contains notable quantities of new
347 dyeing elements which differ in many and essential particulars from any which are found in madder-root or its preparations, and that to the presence of said new dyeing elements said artificial alizarine owes much of the character which has caused it to be used instead of madder and its preparations.

Thus I find that Dr. Chandler in his affidavit above mentioned appears to assert or imply that the use of certain formulæ by Graebe and Liebermann, in describing their process in the report made by them at the Vienna exhibition, involves the statement that nothing but the chemically pure substances which those formulæ represent are present in the product of the said process. Such an interpretation of formulæ is, however, at variance with the universal practice of chemists.

A chemical formula can from its nature express nothing but chemically pure substances, but nevertheless is constantly used in describing reactions to indicate *that part* of the material present in a process or in its product which is the special subject of explanation, without in any way implying that any number of other substances are not present at the same time in the said reaction or its product. Thus, for example, these very authors Graebe and Liebermann in the *Annalen der Chem. und Pharm.*, Sup., vol. 7, p. 278, speaking of the bibromanthracentetrabromide, say:

"According to Anderson's method exposure of anthracene in thin layers to vapors of bromine, the preparation generally succeeds badly and the yield is small, there being formed brown sticky matters.

* * * * * * * * *

"The action of bromine upon dry anthracene, therefore, corresponds to the equation $C_{14} H_{10} + 8 Br = C_{14} H_8 Br 2 Br_4 + 2 Br H$."

Here we have no notice whatever in the formula of the brown sticky matters, but no chemist would be deceived or be surprised after seeing such a formula to find them, even if nothing had been said about them by the author.

Such illustrations might be multiplied without limit, but I need only refer to those given at pages 62 and 63 of my testimony in the suit of this complainant *vs.* T. K. Cummins, and to my affidavit on page 69 of, papers in rebuttal on motion for preliminary injunction in the same case.

In reference to Dr. Chandler's assertion or suggestion that artifi-

cial alizarene when made in the manner directed by Graebe and Liebermann contains nothing but chemically pure alizarine—so far as it is a dyestuff—I should remark:

First, that it does not appear from his testimony that Dr. Chandler has himself made any experiments on which he could found such an opinion.

On the other hand, I have myself repeatedly made artificial
348 alizarine according to the process described in complainant's patent, and have never failed to find in the product notable quantities of efficient dyeing elements which were not chemically pure alizarine, but corresponded in their properties with the descriptions which have been given by various authors of the substances named by them respectively anthrapurpurine, isopurpurine, and flavopurpurine. In addition to various other experiments previously made, I have recently, at the request of complainant's agents, made up according to the patent a considerable quantity of artificial alizarine by heating bibromanthrachinone prepared from anthracene, with caustic soda, caustic potash and water in the prescribed proportions at the specified temperature, and obtained a large amount of yellow flocks, of which a specimen is contained in the bottle marked "Morton Exhibit A." With these yellow flocks I have made a variety of tests, which convince me that they contain a notable amount of the valuable dyestuffs which may be described by the general name of "isomeric purpurines," these being the bodies I have already named as anthrapurpurine, isopurpurine and flavopurpurine. Thus, for example, these yellow flocks, when used upon the mordanted cloth employed for such tests, give tints characteristically different from those obtained with chemically pure alizarine, and closely approaching those obtained with the commercial artificial alizarine known as artificial alizarine D. When treated with baryta water they do not form an insoluble precipitate, leaving a clear solution, as is the case with chemically pure alizarine, but leave a highly-colored solution of isopurpurine or flavopurpurine. Their alkaline solutions have the red color characteristic of the isomeric purpurines as distinguished from the violet tint which characterizes alizarine. I further separated these yellow flocks by fractional crystallization from solution in water, and thus obtained a quantity of material corresponding in its various reactions and tests with the isomeric purpurines above mentioned, and not with chemically pure alizarine.

I also made dyeing tests upon portions of the same piece of mordanted woollen flannel with chemically pure alizarine made by myself from madder, and with the yellow flocks of artificial alizarine above described, and with Meissonier's extract of madder, and which I annex hereto, marked with the name of the material with which they were dyed.

Deponent moreover says that if the product of this process of complainant's patent were chemically pure alizarine, it would not be an efficient substitute for madder and its extracts.

I have read the affidavits referred to by said Cochrane, a number

of which purport to be by practical calico printers and dyers, and that these, so far from contradicting the assertion made by me—that the artificial alizarine of Graebe and Liebermann's patent is not chemically pure alizarine—sustain my assertion by their statements that artificial alizarine, by which name the product of Graebe and Liebermann's process is known, produces a wide range of
349 colors and shades of colors in dyeing and calico printing, which could not be true of it were said product chemically pure alizarine.

In reference to the affidavit of Gustav Auerbach, of March 25, 1878, I find that it is made up of statements which, almost without exception, are either at varience with the facts recorded in the literature of the subject, or well known to myself and others personally, or which display an apparent ignorance of very elementary chemical principles, and moreover are in certain places self-contradictory. Thus, for example, in folio 97, it contains an admission of the very point which the affidavit seems intended to deny, namely: that all processes of producing artificial alizarine, whether by the use of sulphuric acid, bromine or chlorine, or the like, result in the production of a product which, in addition to chemically pure alizarine, contains "higher hydroxylized anthrachinones," such as anthrapurpurine, &c. Thus he says:

"All patents taken out for the manufacturing of alizarine from anthracene give a more or less high temperature for the treatment of the anthracene resp. the anthraquinones with sulphuric acid, with bromine and chlorine, etc., etc., by which sulpho-acids resp. other substitutional products are formed, which, when afterwards fused or melted with potash or soda, yield higher hydroxylized anthraquinones."

I therefore do not find in his affidavit anything which can be called new evidence, at variance with my previous testimony in this suit. I have discussed his affidavit and pointed out his various errors, etc., in my affidavit in the Cummins suit.

In reference to the affidavits of Carl Otto Neuhaus and Carl Rumpff, which are copies of each other, I have to say that neither of them contradicts my statement that the process of Graebe and Liebermann produces, in addition to chemically pure alizarine, other dyestuffs of practical value, and that the product of said process is, therefore, a new composition of matter, and is not chemically pure alizarine. They simply state that, "upon certain changes in a previous process in the manufacture of 'alizarine from anthracene,' depends the development of a perfectly pure alizarine, or one containing anthra or iso-purpurine, or flavo-purpurine, all of which are "higher hydroxylized anthrachinones."

This, therefore, amounts simply to the statement that they can, by "certain changes" not described, obtain chemically pure alizarine; but they do not assert that such product is the result of the process described by Graebe and Liebermann. This, therefore, is no contradiction of my statement, nor any new evidence bearing on

this case. The defendant's alizarines examined by me, and
350 for the selling of which this suit is brought, was not chemically pure alizarine, nor has any such been produced in connection with this case, except what I myself prepared from madder, portions of which I gave to Professor Ordway and Mr. Carl Pickhardt. I have carefully read over my cross-examination in the Cummins case, and so far from finding that it proves that the original patent of Graebe and Liebermann was for perfectly pure alizarine, having the formula $C_{14}H_8O_4$, consider that it very conclusively demonstrates the contrary.

In respect to the authorities quoted in the pamphlet entitled "Professors Graebe and Liebermann on Artificial Alizarine," I have to say that they were all published and were in this country long prior to the commencement of this suit, and for that reason cannot properly be described as new evidence. The first three references were already quoted in the proofs of complainants in this suit; the English provisional specification of 1868, the English pat. of 1868, the U. S. pat. of 1869, were already in the case; the remaining patents and documents referred to in said pamphlet were published and accessible, and simply cover, as I have already shown, processes equivalent to the original form of Graebe and Liebermann, while the "Report of the Vienna Exhibition," published in 1874, was likewise accessible, and, indeed, was referred to by quotation in the proofs of complainants. I therefore find it difficult to perceive how any of these can properly be regarded as newly-discovered evidence.

HENRY MORTON.

Subscribed and sworn to this day of Nov., 1878.

R. E. STILWELL,
U. S. Com'r for southern dist. of N. Y.

351 United States Circuit Court, southern district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

CITY OF BOSTON, DISTRICT OF MASSACHUSETTS, *ss.*

JOHN M. ORDWAY, being duly sworn, deposes and says:

I reside in Boston, in the state of Massachusetts, and am professor of industrial chemistry and metallurgy in the Massachusetts Institute of Technology. I have given testimony in the present case. I have prepared artificial alizarine from pure bibromanthrachinone substantially according to the directions given in the specification of Graebe and Liebermann in letters patent No. 95,465, dated October 5th, 1869, and reissue No. 4321, dated April 4th, 1871.

I have dyed mordanted swatches of cotton with the alizarine so made, with chemically pure alizarine prepared from madder, and

with the artificial alizarine of commerce marked V. D. Portions of these swatches, after dyeing, I boiled in a solution of soap for five minutes, and then washed and dried. I find the reds produced with aluminous mordants by the artificial alizarine made from bibromanthrachinone fuller, brighter, and of better tint than those given by the chemically pure alizarine, and agreeing very closely with those yielded by the commercial artificial alizarine V. D. This color test gives me sufficient proof that there is in the artificial alizarine, which I have made from bibromanthrachinone, another coloring matter besides alizarine—a coloring matter which gives better tints with alumina, but contributes no brilliancy to the purples given by iron. The dyeing test gives sufficient proof that the coloring matters contained in the artificial alizarine made from bibromanthrachinon are the same as those contained in the ordinary artificial alizarines of commerce, which are generally reputed to be made from sulphanthrachinone. By the dyeing test I obtain from the artificial alizarine, which I made those modifications of, colors which are known to be due to the presence of the isomers of purpurine.

352 I therefore consider that when the directions of the specification of Graebe and Liebermann's patent are followed, the result will be yellow flocks, containing, besides alizarine, a portion of the valuable dye-stuff anthrapurpurine. I cannot say that it is absolutely impossible to make alizarine from anthracene without anthrapurpurine as a by-product, but I have met with no valid evidence that alizarine ever has been made without anthrapurpurine as a by-product.

Herewith I make exhibits marked respectively "Ordway No. 10" and "Ordway No. 11."

In Exhibit No. 10 the swatch marked V was dyed with pure alizarine, in paste, which had been carefully made by Prof. Morton; the swatch marked C was dyed with some of the artificial alizarine, in paste, which I prepared from bibromanthrachinone; the swatch marked G was dyed with artificial alizarine VD, furnished by Wm. Pickhardt and Kuttroff. In Exhibit No. 11, the swatch marked W was torn off from V of No. 10, and boiled five minutes in a weak solution of olive oil soap; the swatch marked D was torn from C of No. 10, and was boiled in the same solution of soap; the swatch marked H was torn from G of No. 10, and boiled in the same solution of soap.

In all the dyeings the residual bath was proved with more mordanted cloth, and found to be unexhausted of coloring matter.

A comparison of the soaped swatches shows plainly that chemically pure alizarine lacks something which the artificial alizarine made by Graebe and Liebermann's original method does impart to aluminous mordants. It is also plain that this lack of bright red coloring matter seriously impairs the value of chemically pure alizarine as a dyeing material.

JOHN M. ORDWAY.

UNITED STATES OF AMERICA,
District of Massachusetts.

Nov. 14, 1878.

Subscribed and sworn to before me, and I have marked the exhibits referred to with my initials and official designation.

JOHN G. STETSON,
U. S. Commissioner.

[SEAL.]

353 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

CITY, COUNTY, AND STATE OF NEW YORK,
Southern district of New York, } *ss.*

CARL PICKHARDT, being duly sworn, deposes and says: That he resides in New York city. That he studied chemistry under Prof. Rosenstiehl, and has given much attention to chemistry as applied to dye-stuffs and coloring matters. That he has read complainant's reissued patent No. 4321, and believes he understands the invention therein described; that he has, within the past three years, made, at least nine times, the yellow flocks of artificial alizarine according to the process described in said patent, several of said operations being made in this present month of November, 1878, and produces some so made by him in this present month, contained in the bottle hereto annexed, marked "Exhibit No. 1." That deponent has made dyeing tests with some of the artificial alizarine obtained from the same operation, from which Exhibit No. 1 is a part, on mordanted cloth, prepared for dyeing with preparations of madder, and produces swatches of the same, marked "Exhibit No. 2."

Deponent further says that he has made an extract from another part of the artificial alizarine, obtained from the same operation from which Exhibit No. 1 was taken, by boiling the same in water and filtering while hot; a portion of it dissolved in the hot water, and the undissolved portion remained on the filter; on allowing the filtrate to cool yellow flocks deposited, with some of which deponent made another dyeing test, and produces swatches thereof, marked "Exhibit 3," using for that purpose a piece of the same mordanted cloth, as before.

Deponent further says that he has also made a dyeing test on a piece of the same mordanted cloth with chemically pure al-
354 izarine furnished to him by Prof. Henry Morton, and deponent has annexed hereto swatches of said cloth dyed with said chemically pure alizarine, marked "Exhibit 4." That on examining the swatches "Exhibit 3" it is seen that the extract obtained by deponent, as aforesaid, dyes the mordanted cloth with the characteristic colors of anthrapurpurine, as described by Perkin in the Journals of the Chemical Society, London, differing from chemi-

with the artificial alizarine of commerce marked V. D. Portions of these swatches, after dyeing, I boiled in a solution of soap for five minutes, and then washed and dried. I find the reds produced with aluminous mordants by the artificial alizarine made from bibromanthrachinone fuller, brighter, and of better tint than those given by the chemically pure alizarine, and agreeing very closely with those yielded by the commercial artificial alizarine V. D. This color test gives me sufficient proof that there is in the artificial alizarine, which I have made from bibromanthrachinone, another coloring matter besides alizarine—a coloring matter which gives better tints with alumina, but contributes no brilliancy to the purples given by iron. The dyeing test gives sufficient proof that the coloring matters contained in the artificial alizarine made from bibromanthrachinon are the same as those contained in the ordinary artificial alizarines of commerce, which are generally reputed to be made from sulphanthrachinone. By the dyeing test I obtain from the artificial alizarine, which I made those modifications of, colors which are known to be due to the presence of the isomers of purpurine.

352 I therefore consider that when the directions of the specification of Graebe and Liebermann's patent are followed, the result will be yellow flocks, containing, besides alizarine, a portion of the valuable dye-stuff anthrapurpurine. I cannot say that it is absolutely impossible to make alizarine from anthracene without anthrapurpurine as a by-product, but I have met with no valid evidence that alizarine ever has been made without anthrapurpurine as a by-product.

Herewith I make exhibits marked respectively "Ordway No. 10" and "Ordway No. 11."

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In all the dyeings the residual bath was proved with more mordanted cloth, and found to be unexhausted of coloring matter.

A comparison of the soaped swatches shows plainly that chemically pure alizarine lacks something which the artificial alizarine made by Graebe and Liebermann's original method does impart to aluminous mordants. It is also plain that this lack of bright red coloring matter seriously impairs the value of chemically pure alizarine as a dyeing material.

JOHN M. ORDWAY.

UNITED STATES OF AMERICA,
District of Massachusetts.

Nov. 14, 1878.

Subscribed and sworn to before me, and I have marked the exhibits referred to with my initials and official designation.

JOHN G. STETSON,
U. S. Commissioner.

[SEAL.]

353 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

CITY, COUNTY, AND STATE OF NEW YORK,
Southern district of New York, } *ss.*

CARL PICKHARDT, being duly sworn, deposes and says: That he resides in New York city. That he studied chemistry under Prof. Rosenstiehl, and has given much attention to chemistry as applied to dye-stuffs and coloring matters. That he has read complainant's reissued patent No. 4321, and believes he understands the invention therein described; that he has, within the past three years, made, at least nine times, the yellow flocks of artificial alizarine according to the process described in said patent, several of said operations being made in this present month of November, 1878, and produces some so made by him in this present month, contained in the bottle hereto annexed, marked "Exhibit No. 1." That deponent has made dyeing tests with some of the artificial alizarine obtained from the same operation, from which Exhibit No. 1 is a part, on mordanted cloth, prepared for dyeing with preparations of madder, and produces swatches of the same, marked "Exhibit No. 2."

Deponent further says that he has made an extract from another part of the artificial alizarine, obtained from the same operation from which Exhibit No. 1 was taken, by boiling the same in water and filtering while hot; a portion of it dissolved in the hot water, and the undissolved portion remained on the filter; on allowing the filtrate to cool yellow flocks deposited, with some of which deponent made another dyeing test, and produces swatches thereof, marked "Exhibit 3," using for that purpose a piece of the same mordanted cloth, as before.

Deponent further says that he has also made a dyeing test on a piece of the same mordanted cloth with chemically pure al-
354 izarine furnished to him by Prof. Henry Morton, and deponent has annexed hereto swatches of said cloth dyed with said chemically pure alizarine, marked "Exhibit 4." That on examining the swatches "Exhibit 3" it is seen that the extract obtained by deponent, as aforesaid, dyes the mordanted cloth with the characteristic colors of anthrapurpurine, as described by Perkin in the Journals of the Chemical Society, London, differing from chemi-

cally pure alizarine by producing reds which are much more scarlet and purer than those of the latter, while the purple is bluer and more slaty; while the fastness of the colors against soaping is quite equal to those produced with alizarine.

Deponent further says that all of the dyeing tests above mentioned were made under the same conditions.

Deponent further says that he has made dyeing tests on pieces of bleached woollen flannel mordanted and prepared for dyeing scarlet on woollen cloth with madder, or preparations of madder; first, with another part of the artificial alizarine obtained from the same operation from which Exhibit No. 1 was taken: second, with said chemically pure alizarine procured by him from Prof. Morton; and, third, with Meissonier's commercial madder extract, and that he has annexed hereto swatches of said tests, each marked with the name of the material with which deponent dyed the same.

Deponent further says that all of the dyeing tests on flannel were made under the same conditions.

Deponent further says that the scarlet obtained with Meissonier's madder extract results chiefly from the effects of alizarine and purpurine combined, which are contained in it; according to the investigations of Rosenstiehl, it contains forty-five parts of alizarine and fifty-five parts of purpurine, published in:

Jahres Bericht, ueber Leistungen der Chemischen Technologie, 1875, von Rudolf *v.* Wagner, p. 937.

Also in

Bullet. de la Soc. Industr. de Mulhouse, 1875, p. 55.

American Chemist, 1875, V. Nr. 9, p. 348.

CARL PICKHARDT.

Sworn to and subscribed before me, this 18th day of November, 1878.

R. E. STILWELL,
U. S. Com'r for southern district of N. Y.

355 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

In opposition to Rehearing.

CITY, COUNTY AND STATE OF NEW YORK,
Southern district of New York, } *ss.*

WILHELM PICKHARDT, being duly sworn, deposes and says: That he has read the affidavit of Prof. Charles F. Chandler in this suit, dated November 20th, 1878, and finds therein, p. 34, as follows:

"I have carefully read the testimony in the various cases brought by the Badische Anilin and Soda Fabrik Company, both the testi-

mony for the complainants and for the defendants, and I am familiar with the general literature with reference to the production of alizarine.

"Graebe and Liebermann, having discovered the composition of alizarine, invented their bromide process, as set forth in their patent, for producing from anthracene this alizarine, the composition of which they had determined.

"All the publications of Graebe and Liebermann in this matter show that they desired to produce nothing but pure alizarine.

"The chemical formulas given by them in their publications and in their patents and in all their statements show absolutely to a chemist that they only had one result in view, namely, the production of alizarine, which was known to them to be a definite compound, viz: 'C_{14} H_8 O_4.'

"The production of alizarine from anthracene in the way above referred to by Graebe and Liebermann is by all chemists considered a most brilliant triumph of synthetic chemistry, but this triumph consists in the fact that Graebe and Liebermann, having discovered the constitution of alizarine from madder, were able from anthracene to produce alizarine of the same identical composition.

356 "For some time chemists doubted that Graebe and Liebermann had produced alizarine, but Graebe and Liebermann always maintained that they had done so by the bromine process, and chemists generally now agree that Graebe and Liebermann by the bromine process did produce alizarine."

From which deponent understands that Prof. Chandler means to convey the idea:

I. That Graebe and Liebermann intended to produce chemically pure alizarine only.

II. That all the publications of Graebe and Liebermann show that they desired to produce nothing else.

III. That by their bromine process they did so produce it.

IV. That for some time chemists doubted that Graebe and Liebermann had produced it.

V. That Graebe and Liebermann maintained that they had.

VI. That it is now generally agreed by chemists that they had.

To which deponent replies:

That he is familiar with the history and general literature of artificial alizarine from anthracene, and that Prof. Chandler, by making the above statements, states the facts wrongly.

Deponent says that the facts are, that Graebe and Liebermann intended to produce a dyestuff which would be a fit substitute for madder; that many chemists had intended to do so before them and failed, notably Roussin, in April, 1861, and Martius and Griess, in the year 1866. In the *Moniteur Scientifique* May, 1871, pp. 291–298, P. Alfraise, who, speaking of the second attempt, says as follows:

"Second Pseudo-alizarine or Oxynaphtalic acid of Messrs. Martius and Griess.

"As we have said above, the greatest number of chemists and the

most reliable ones admitted that alizarine must be oxynaphtalic acid. During numerous years the problem to solve and to obtain the synthesis of alizarine, was the preparation of this acid, which the adroitness of Laurent had not succeeded to prepare. The same as in inorganic chemistry, it is to-day considered that the manufacture of dia-
357 monds will be solved the very day when a proceeding to crystallize carbon will be discovered, so was it considered before 1866 that the synthesis of alizarine would be solved by the discovery of a proceeding to make oxynaphtalic acid.

"But bitter was to be the disappointment of the two chemists who succeeded the first to prepare this acid."

Graebe and Liebermann succeeded to produce a dyestuff from coal-tar, which has proved to be a fit substitute for madder, which has had the effect of reducing the cultivation of madder to nothing, or to a nominal amount, in France. In their first communication about their dyestuff published in the "Berichte der Deutschen Chemischen Gesellschaft zu Berlin," page 14, read at the meeting of January 11th, 1869, of the Chemical Society, they say in the last and 3d paragraph, of which I herewith furnish a translation:

"Of what importance our discovery will prove to be for the madder industry it it can be made successfully available for technical purposes we need not point out particularly. The enormously large consumption of madder in calico print works, the large tracts of fertile lands which are necessary for its cultivation, show sufficiently clear the importance which a new branch of industry would obtain which would be based on the artificial production of alizarine from one of the substances of coal-tar oil."

In another publication at about the same time, i. e., within four weeks of the invention, they say: (Deponent furnishes a translation.)

Bulletin de la Societe Industrielle de Mulhouse, tome XXXIX, 1869, pp. 46, 47. Meeting of 27th January, 1869. Note on artificial alizarine, by Gustave Schaeffer.

"GENTLEMEN: A discovery of the greatest importance, from a scientific and technical point of view, has just been made at Berlin.

"Artificial alizarine has been found; two chemists, Messrs. Graebe and Liebermann, have announced at the meeting of the Berlin Chemical Society, held on the 11th January inst., that their researches have been crowned with success; they have presented specimens of the new product which is identical with alizarine extracted from madder, and gives the same results in dyeing.

358 "I have addressed myself directly to Mr. Liebermann, asking for an exact account of this great discovery which has been made by him and his fellow chemist, Dr. Graebe. I lay on the table the letter which I received; the following is a translation:

"'I am able to confirm the truth of the news which you have received in regard to artificial alizarine; after a year of work and after having indicated theoretically the results which we wished to obtain,

we have come to prepare artificial alizarine, which, by dyeing, gives the same results as madder.

"'The quantities which we have been able to produce up to the present time are very small, and we know not yet whether we will be able to produce this new product technically, but we continue to occupy ourselves actively with this question. I send with my letter small specimens of the dyed stuffs which may be exhibited at the approaching reunion of the Industrial Society. As soon as I am able to obtain the proofs of our publication on the subject of artificial alizarine, I will not fail to place them at your disposal. I authorize you, both in my name and in that of Dr. Graebe, to communicate my letter to the Industrial Society. So soon as the circumstances will permit I will follow with a complete account of our process.'

"After the accounts which come to me from Dr. Goldschmidt, corresponding member of our society, Messrs. Graebe and Liebermann have obtained artificial arizarine by heating anthracene, (one of the products of the distillation of coal-tar at about 200° C.")

Deponent further says that Mulhouse is a large manufacturing town in Alsace, being at that time a part of France; that the largest and most extensive calico print works and dye works on the continent of Europe are located there and in its immediate neighborhood; that the Societe Industrielle de Mulhouse is in part composed of the most eminent and celebrated calico printers, dyers and chemists; that Charles Liebermann, one of the inventors of artificial alizarine, was at that time a member of it; that Charles Liebermann is a calico printer and chemist; that he learned his trade at his father's print works in Berlin, and that he went to Mulhouse and remained there for some time in order to improve his knowledge in calico printing and dyeing; that the request above referred to about information, regarding the invention of Graebe and Liebermann, came from practical printers to a practical printer who understood by "alizarine" commercial extracts of madder, as was generally the case.

Deponent further says that Prof. Chandler understood the commercial extracts of madder as being alizarine, for in the suit of complainant against Higgin et al. he testified, in answer to

"Q. 4. What is alizarine, if you know?

359 "A. * * * Several processes have been employed for extracting the alizarine either from the madder root or from the preparations of the root which I have mentioned."

And then enumerates fourteen different processes for the extraction, and then says:

"All of these processes accomplish the extraction of alizarine from the madder root, yielding it in a condition if not of absolute purity, yet sufficiently pure for use in dyeing and calico printing. Most of these processes have been employed on a manufacturing scale—some of them are still so employed, the products being known in commerce as alizarine or madder extract."

And so Prof. Chandler does now; for in his affidavit in the Cummins case, dated April 24, 1878, he states, on p. 31:

"If by the words 'identical conditions,' it is meant, as I suppose it is, that the mordanted cloth shall be identical in both cases, or that in topical printing the mordants used shall be identical, then it may or may not be true in some particular case that the results of the artificial alizarine may be superior to those of natural alizarine, and it may be true that those results will be inferior. Under identical conditions, any two samples of madder preparations, if the madder has been produced in different parts of the world, or the preparations have been made by different manufacturers, will produce different results, one of which will be superior to the other; and the same is true of different varieties of artificial alizarine as compared with each other. In all cases, whether artificial or natural alizarine is used, it is necessary to adapt the conditions of use to the quantity of dye in order to produce the desired results."

And so does John Bracewell, in his affidavit in the Cummins case, dated April 18th, 1878.

And also Henry Burrows, in his affidavit in the same case, dated April 18th, 1878.

Also Wm. Bogle, in his affidavit in the same case, dated April 20th, 1878.

Also Thomas Walsh, in his affidavit in the same suit, dated April 15th, 1878.

Deponent further says that madder is the English name and *garance* is the French name for a dyestuff obtained from the madder plant; it is the matured root of the plant dried, cured and prepared ready for dyeing; that some preparations of madder
360 or commercial alizarines were not fit for printing on account of the injurious impurities they contained, such as resinous matters, gums, green-colored matters, vegetable fibres, &c., but all of them could be used for dyeing; only a few of them were really used prior to 1869 for printing.

The Moniteur Scientifique of September 15, 1869, contains an article, p. 875:

"On the application of Extracts of Madder in Calico Printing, and the part each of the Different Pigments contained in Madder Plays in this Operation. By Mr. P. Schutzenberger.

"Notwithstanding the numerous discoveries of colors derived from aniline, madder has maintained its rank among dyes used in the manufacture of calicoes.

* * * * *

"The efforts recently tried and crowned with success to fix madder or its pigments directly by printing, have been favorably accepted. The advantage is easily understood, which results from such a revolution in this industry. The manufacturer prints at once with one machine 6, 8, 12, or even 24 colors, all the shades of a pattern, and fixing the fast colors as well as the others, all at the

same time by one and the same agent, steam. The saving of time and labor by this process is very considerable.

"So radical a change in the secular habits of a great industry, a change which overcomes a very cumbersome, large material, cannot be made suddenly; but in the actual state of affairs it can be foreseen with great certainty that madder *dyeing* will be entirely replaced by *printing*.

* * * * *

"At Cosmanos, in Bohemia, and almost at the same time in the factory of Scheurer, in Thann, this process has been applied with great success, but only after long researches this difficult problem has been solved—i. e., to print directly with alizarine on cloth not mordanted.

"One of the principal conditions necessary to its success is the use of a very pure and a very rich madder extract."

Deponent says that Graebe and Liebermann did not give chemical formulæ in their patents for the product obtained by them. In the specification of their French patent, which is published in the Moniteur Scientifique, Paris, 1869, pp. 465–6, and dated December
361 14th, 1868, which is probably the very first communication of Graebe and Liebermann on their invention, they say in their specification, of which I herewith render a translation:

"In treating the last mentioned bodies, the bibromanthrachinon and the bichloranthrachinon, with a very concentrated caustic alkali solution, at a temperature of 180 to 260° C, the liquid is seen to take a beautiful blue coloration, which becomes more and more dark. When this does not augment any more the operation is terminated. After cooling, it is extracted by water, and the solution so obtained is precipitated by any acid.

"The coloring matter is precipitated as yellow flocks, which are gathered on a filter and carefully washed. The precipitate is alizarine in such a state of purity that it can be applied successfully not only for dyeing but also for printing."

Graebe and Lieberman use in this French patent chemical formulæ until they mention bibrom and bichlor anthrachinone, or until where the above quotation begins, which comprises the end of the specification. The provisional specification of the English patent, which is dated four days later, namely, 18th December, 1868, appears to be a negligent translation of the French patent.

Deponent further says that Graebe and Liebermann were of opinion that their dyestuffs gave in dyeing the same results as madder; they were even of opinion that the *madder purpurine was also in the composition of their dyestuff*, and in order to ascertain whether this was a fact, they sent some of it to London to have it tested with the spectroscope by Prof. Stokes; that in their publication in the *Annalen der Chemie und Pharmacie*, Leipzig, 1870, p. 257, "On Anthracen and Alizarin," they state on p. 303:

"A similar oxydation seems to lead sometimes in a limited manner to the formation of purpurine in the fusion of bibromanthrachinone with caustic alkali, but hitherto we were unable to prove this with absolute certainty. * * * *
With reference to science it is allowable to point out that the successful production of alizarine by us is for the first time the imitation by synthesis of a coloring matter from the vegetable kingdom. But principally is it of great importance for industry. There are authorized hopes that our invention will be enabled to found a great extensive industry for working a raw material which was hitherto
362 useless, and which by and by will diminish the cultivation of madder, and probably entirely supplant it."

Deponent further says that the controversy which took place after the invention of artificial alizarine by Graebe and Liebermann, by many chemists, was not, as Prof. Chandler intimates, whether Graebe and Liebermann had produced alizarine chemically pure, or not, by their bromine process, but whether it had any relation whatsoever to madder.

Many able chemists positively asserted that their new dyestuff had no relation whatever to the coloring principles of madder. The very first publication which is made on the subject is found in the "Moniteur Scientifique," Paris, 1869, pp. 873–874, by P. Alfraise, in which he says, after enumerating the results of his various tests on artificial alizarine:

"That it is neither alizarine nor purpurine,"

and by Camille Koechlin, of Mulhouse—one of the most eminent and celebrated calico printers in the world—in a letter dated September 7th, 1869, addressed to the editor of and published in the *Moniteur Scientifique*, 1869, pp. 874–5 and 913–16, who says: (Translation.)

"I have the satisfaction to announce to you that the artificial alizarine you sent me has yielded on trial *superior* colors to those yielded from madder or its commercial derivatives. These colors possess new qualities, they *differ* from those of purpurine, and have *fortunately nothing in common* with those of alizarine. The reds are more scarlet, the chocolates are richer, the iron mordants are dyed better. It is madder under a new constitution, *uniting* marvelously the qualities of alizarine with those of purpurine, with the *exception*, however, that the pinks are yellowish.

"Although this synthetic rival * * * is for science not the alizarine of the alizaris, a coloring matter which is generated at a very low temperature, it is for industry *infinitely* more than this alizarine, *it is the madder of the future*, and by recognition it is the solution of Laurent's problem." (Italics are deponent's.)

Another elaborate article on the subject is found in the *Moniteur Scientifique*, May, 1871, pp. 291–298:

363 *Memoirs to serve the history of the discovery of veritable Artificial Alizarine.*—By P. Alfraise.

§ I. ORIGIN of our researches on this discovery.

Since the appearance in 1859 of the beautiful red coloring matter *fuchsine*, obtained artificially with commercial aniline, we were convinced that the synthesis of alizarine, other red coloring matter contained in madder (autre matiere colorante rouge centenue dans la garance), became more and more probable and possible, regardless of the failures which chemists had experienced who had tried it. * * *

§ II. HISTORY of divers researches which have been made since the discovery of alizarine until that of its synthesis.

"In 1849 Laurent and Gerhardt, in submitting alizaric acid, obtained as we have said before by the action of boiling nitric acid on alizarine. * * *

"To this first and grave error has soon been added another and graver one. Two German chemists, Messrs. Graebe and Liebermann, in submitting to dry distillation a mixture of pulverized zinc and alizarine found among the products that were produced anthracene. To conclude that alizarine was derived from anthracene was for these two chemists the most beautiful dream of their calculations. We hasten to say, however, in addition that this illusion was not without results, because it led to the discovery of a new fast coloring matter which does not exist in madder. * * *

"THIRD PSEUDO—Alizarine or alizapurine or anthrazarine of Messrs. Graebe and Liebermann.

"We hasten to say that if the alizapurine is not alizarine, it is, nevertheless, a beautiful fast coloring matter, and produces on madder prints almost the same colors as the alizarine. * * *

"We have shown from the commencement * * * that it was not alizarine, but a new fast coloring matter unknown until now, and which does not exist in madder.

"We will give here the historical part of this new coloring matter.

"Messrs. Graebe and Liebermann found among the decomposed products of alizarine heated with zinc dust on an open fire a solid hydrocarbon which they recognized to be anthracene."

364 There were also in England eminent chemists and calico printers and dyers who were of about the same opinion, whose investigations and reports are published in the *Chemical News*, by J. Wallace Young, who in his publication on artificial alizarine (*Chemical News*, London, January 28th, 1870, pp. 43 and 44) says at the conclusion of a long report of various tests on artificial alizarine:

"The author was not aware if anything had been done towards establishing a formula for the new alizarine, but his opinion arrived at after performing many practical experiments, was that there was

some essential difference between the artificial and the natural substance."

Deponent further says that Prof. Chandler in his testimony in the Higgin case quotes, in answer to Q. 10 (p. 23, fol. 68, def't's record), the above mentioned publications of P. Alfraise in the *Moniteur Scientifique* of May, 1871, and of Young in the *Chemical News*.

Deponent finds other publications in the *Chemical News* of the same tenor; one by Mr. John Christie (*Chemical News*, London, February 11, 1870, pp. 67–69), who says at the conclusion of a long report of various tests:

"Graebe and Liebermann noticed that natural alizarine by distillation with powdered zinc yielded a hydrocarbon, which instead of being naphthaline, C_{10} H_8, as they expected, proved to have the same composition as Dr. Anderson, Berthelot, and others had given to anthracen, and believing that this was the proper source to start from in the preparation of artificial alizarine, they set to work to test the truth of the opinion. They were so far successful that they obtained a product closely allied in many of its properties to the coloring matter of madder, and in December, 1868, they obtained provisional protection for their process in this country.

"In the third stage this new compound is transformed into artificial alizarine by treating with potash, heating to 180° or 260° C., till a deep blue color results, then dissolving in water, filtering, and precipitating the alizarine by acid."

Deponent says that the statements quoted above, made by the practical calico printers and dyers, Camille Koechlin, J. Wallace Young and John Christie, have never been contradicted.

These eminently practical men experimented with the dyestuff as a whole and not with dissected parts from it.

Many chemists maintained at that time that alizarine
365 chemically pure could be extracted from Graebe and Liebermann's dyestuff, notably Perkin, who published them at the time in the "Journal of the Chemical Society." In vol. VIII., London, 1870, pp. 133–143, we find on p. 137:

"Thus Graebe and Liebermann succeeded in producing alizarine from anthracene, and have given us the first instance of the artificial formation of a vegetable coloring matter.

"The great importance of alizarin as a dyeing agent rendered it desirable to turn this beautiful discovery to practical account, and, if possible, render alizarine from anthracene a substitute madder. The use of bromine in Graebe and Liebermann's process rendered it, however, somewhat difficult to carry out on a manufacturing scale; therefore it was necessary to find a cheaper and more manageable reagent which might be used in its stead."

Then follow descriptions of processes, and after them, on p. 139:

"I may here mention that while these experiments were in progress, MM. Caro, Graebe and Liebermann were investigating the

same reactions in Germany, and having obtained analogous results, we have agreed in future to work together on this subject."

Then follow descriptions of processes, and after them, on p. 140:

"The coloring matter obtained either by Graebe and Liebermann's original process, or from the sulpho-acid of anthraquinone, I have invariably called *alizarin*. The identity of this substance with the alizarin of madder has, however, been called in question. I have therefore made some experiments upon this subject, and carefully examined these two products side by side. For this purpose I have employed both purified, sublimed, and unsublimed artificial alizarin,* and for comparison, purified sublimed alizarin prepared from madder extract."

And after enumerating six tests which he made, says:

366 "I know of no other well-defined reaction of alizarin, and therefore, judging from these, we are bound to consider artificial and natural alizarin as identical.

"Artificial alizarin has been objected to as a substitute for madder, on the ground that pure alizarin will not produce madder colors, other coloring matters being required.

"Now the only coloring matter in madder besides alizarin, which is not injurious to the beauty of the colors, is purpurin."

Then follow remarks about purpurine; after which he says, on p. 143:

"Artificial alizarine, as supplied to the dyer and printer, is not chemically pure, and usually produces with alumina mordants, colors somewhat redder than madder. * * *

"The shade of color produced with artificial alizarine may be modified to some extent by regulating the temperature of the dyebath, the colors on the alumina mordants being nearer to those produced with madder, when a low temperature is employed. The redder shade produced with this coloring matter is, however, often preferred, especially for turkey red dyeing.

"It has been stated that this is due to the presence of purpurin; this, however, is not the case, as none of this coloring matter can be detected even by Professor Stokes' test; Dr. Schenck has also affirmed this."†

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*"To purify the sublimed artificial alizarin, it was dissolved in aqueous ammonia, and after filtration precipitated with hydrochloric acid. The precipitated coloring matter was then washed, dried, and crystallized from alcohol several times.

"The unsublimed product was purified with alumina by a process similar to that described by Dr. Schunck for the separation of alizarin from madder."

†"When purifying artificial alizarine by converting it into an alumina lake, I found that upon digestion with carbonate of potash, this lake gave a red-colored solution containing a coloring matter dyeing mordants very similarly to alizarine, with this difference, that the reds were more scarlet and the purples bluer or more slaty."

And in vol. X., 1872, p. 659, we find:

"Note on a secondary coloring matter produced in the preparation of alizarin from anthracen.

"In a paper on artificial alizarin, published in the Journal of this Society, I mentioned that there was produced, along with that coloring matter, a certain quantity of a second coloring matter, dyeing mordants very similarly to alizarin, with the difference that the purples were blue and the reds more scarlet.

367 "I have since been examining this body, which is difficult to obtain pure. From numerous combustions it appears to have the formula— $C_{14} H_8 O_5$."

* * * * * *

"This formula is the same as that usually assigned to purpurine. The substance is, however, entirely different in properties from that colouring matter."

* * * * * *

"It also differs from alizarine in many ways. * * * *

"This colouring matter is, therefore, distinct, both from alizarine and from purpurine."

Deponent finds in the "*Jahres-Bericht*," 1877, *von Rudolph v. Wagner*, on p. 931:

"*On the Formation of Alizarine and Anthrapurpurine.*

"W. H. Perkin* brings the following historical notices:

"The first part of his treatise relates principally on aniline dyes; the second part treats on artificial alizarine and offers a double interest, as it brings at times entirely new views on this subject differing from those held till now. According to Perkin, every artificial alizarine contains in more or less parts anthrapurpurine, particularly that produced in England after his method from the year 1869 until the year 1873, and afterwards from the dichloranthracene manufactured product, the same body which Caro obtained from iso-anthraflavic acid, a by-product of the alizarine manufacture, and which Rosenstiehl obtained from the other component part of the anthraflavone."

Deponent further says that the quotations of Prof. Chandler from Perkin's publications on the subject, in his affidavit in the Cummins case, p. 29, folios 74 and 75, dated April 24, 1878, do not show that the absence of anything but pure alizarine was an objection to the use of artificial alizarine, as he implies in folio 74; but that the absence of purpurine on madder prints was no objection to the use of madder for madder prints.

The article from which Prof. Chandler quotes is as follows:

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* "W. H. Perkin, Engineer, 1876, Sp't p. 229."
(deponent has not a copy of the *Engineer* in his possession.)

"I have made some experiments also in this direction, and have found nothing but alizarine on finished madder prints. I could not detect purpurine even with the spectroscope.

* * * * * *

368 "I do not mean to affirm that purpurine never exists on prints dyed with madder or garancine, as there are several classes of goods produced in print works and subjected to more or less soaping, etc."

Perkin states quite the reverse of what Prof. Chandler implies, for right after the article from which Chandler quoted, giving a description of madder purpurine, commences the paragraph:

"Artificial alizarine, as supplied to the dyer and printer, is not chemically pure, and usually produces with alumina mordants colors somewhat redder than madder. * * * *"

Deponent further says that Graebe, Liebermann, and Caro say in their English patent, No. 1936, dated June 25th, 1869, for the use of sulpho-acids of anthrachinone:

"This invention relates to improvements on an invention granted to Charles Liebermann and Charles Graebe for improvements in preparing coloring matters, dated the eighteenth day of November" (December), "one thousand eight hundred and sixty-eight, No. 3850, in which the preparation of artificial alizarine is based upon the action of caustic alkalies upon bibromanthrakinon, or bichloranthrakinon. We have now discovered that a similar result may be obtained by substituting sulphuric-acid for bromine or chlorine in the above process. We thus obtain the sulpho-acids of anthrakinon, which, by being dissolved in and heated with an excess of caustic alkali, are converted into alizarine."

Deponent further says that Prof. Chandler says in his affidavit, for defendants, in this suit:

"Two years ago Schunck and Roemer, in England, discovered that by the same sulpho-acid process there was produced a by-product in addition to alizarine, which they called 'flavo-purpurine.'"

Deponent furnishes herewith fuller quotations from their publications on the subject.

"*On Anthraflavic Acid, a yellow coloring matter accompanying artificial alizarine.*"

By EDWARD SCHUNK, Ph. D., F. R. S.

Chemical News, April 6th, 1871, pp. 157–159.

"The artificial formation of alizarine is a process of so much importance, both theoretically and practically * * * * The

369 process itself, as described by its discoverers, Graebe and Liebermann, seems exceedingly simple, and consists in the conversion of the hydrocarbon anthracene, C_{14} H_{10}, by the action successively of an oxydizing agent, of bromine or sulphuric acid, and of caustic alkali, into alizarine C_{14} H_8 O_4. Nevertheless, the product obtained on a large scale for the use of dyers and printers by this process is very far from being pure alizarine; so far, indeed, that some persons are inclined to doubt its perfect identity with the natural substance.

* * * * *

"A few simple experiments are sufficient to prove that artificial alizarine as ordinarily prepared is always accompanied by other substances, some of which are colored while others are colorless, or nearly so. My object on the present occasion is to describe one of these substances and to point out the relation in which it stands to alizarine.

"My attention was first directed to this part of the subject by the results of some experiments made on a small scale to obtain alizarine from anthracene according to the directions of Graebe and Liebermann. I was surprised to find that in spite of all the precautions taken I always obtained besides alizarine a notable quantity of another body, also crystalline, but dissolving in alkalies with a yellow color. This body bore so strong a resemblance in some of its properties to several of the rubiacine class of coloring matters, substances which are contained in madder along with alizarine, that my curiosity was excited. Having communicated this fact to Mr. Perkin, who, as is well known, is engaged in the manufacture of alizarine on a large scale, he kindly sent me for examination a specimen of the residue obtained by him in evaporating the mother liquors of alizarine. This residue was a crystalline, reddish brown mass, soluble in alkalies with a cherry-red color. I found it to contain in addition to alizarine a quantity of a substance apparently identical with that I had previously obtained directly from anthracene. I afterwards found the same body in commercial alizarine, both in that manufactured by Mr. Perkin and in a sample from a continental firm. I therefore requested Mr. Perkin to supply me with a quantity of his alizarine, sufficient to enable me to prepare a pure specimen of this body, * * * * *

370 which I had named anthraflavic acid in order to indicate its most obvious external property. * * * * *

It is certain, therefore, that by the action of caustic potash, anthraflavic acid is converted into alizarine, the process being doubtless one of oxidation, though it should be stated that the conversion is never complete."

Deponent says that the last named author, Schunck, investigated further with H. Roemer this anthraflavic acid and published the results in the *Berichte der Deutschen Chemischen Gesellschaft*, 1875, p. 1628, and 1876, p. 379 and pp. 678–682, in which they state that

they discovered in artificial alizarine an isomeric anthraflavic acid which they named isoanthraflavic acid, and then state on p. 679:

"We have now found that each of the two acids yield on fusion with alkali a purpurine, i. e. isoanthraflavic acid, the anthrapurpurine as described by Perkin, and the anthraflavic acid, a new purpurine which we will at present call flavopurpurine.

"The statement of one of us" (in 1871), "according to which anthraflavic acid was converted into alizarine by the fusion of caustic alkali, is to be corrected accordingly."

Deponent says that most of the publications made at about the time on this subject are only theoretical speculations, until we come to the investigations of A. Rosenstiehl, whose researches are published in the *Bulletin de la Societe Chemique de Paris*, 1875, pp. 153–160 and 204–216. In the *Moniteur Scientifique*, June, 1875, pp. 562–570, the well known chemist Alfred Naquet, author of *Principes de Chimie*, Paris, 1865, a text book used in educational institutions in France, makes a resumé of Rosenstiehl's researches, of parts of which deponent herewith furnishes a translation:

"Preparation of pure Alizarine and its Tinctorial Properties.

"Before the discovery of artificial alizarine, different madder extracts were used for preparing alizarine, lately, especially green and yellow alizarines produced from Alsace madder according to Kopp's process. Unfortunately these green and yellow alizarines contain purpurine, which cannot be separated from alizarine by the recommended methods of purification. Mr. Stenhouse recognized this impurity at first, and Mr. Stokes, a little later, averaged the pro-
371 portion of purpurine to be 30 from 100 of the total mass. It is evident that from such a starting point all the analyses and all the descriptions of alizarine must be considered false. *

"The shades obtained with alizarine from madder root differ from those obtained with artificial alizarine, and if it is true that by purifying the one or the other either by sublimation or by successive crystallizations the differences have been attenuated, it is equally true that till the present nobody has succeeded to make the difference disappear entirely. It is but quite recently that Rosenstiehl has succeeded to produce identical shades with the two alizarines by a method discovered by chance by him. * * *

"Pure alizarine sublimed from alcohol is in the form of fine yellow needles, or in the form of scales; the color is the more orange the thicker they are. At equal dimensions the crystals from artificial alizarine are less red than those prepared according to the indications of the classical works, which always contain purpurine. * *

"Pure alizarine stirred up in distilled water dyes mordanted tissues very imperfectly. The mordants do not become saturated unless an aqueous solution of carbonate of lime is added to the dye-bath. As this salt is, however, little soluble in water, it is better to dissolve it in water previously charged with carbonic acid. * * *

"In water charged with carbonate of lime, alizarine behaves in a

characteristic manner. Left in a closed vessel and cold, the two substances act very slowly one upon the other; the reaction takes place more rapidly when heat is applied. * * * *"

Deponent further says that the facts above referred to are known to Prof. Chandler, for these investigations of Rosenstiehl are published in a translation in Chandler's American Chemist, 1875; in his testimony in the Higgin suit he says in answer to—

"Q. 15. To what are these differences supposed to exist, by the persons you have named, between the two kinds of alizarines, due?

"A. They were due to the fact that these chemists experimented with impure alizarine; as these differences do not occur when pure alizarine from madder is compared with pure alizarine from anthracene."

372 Deponent further says that the quotations and translations of Prof. Chandler from Graebe and Liebermann's publications in the various suits on artificial alizarine, in which he has given testimony, are inaccurate.

The first description of artificial alizarine by Graebe and Liebermann is probably the French patent, dated December 14, 1868, which is copied in the Moniteur Scientifique, May 15, 1869, p. 465, of the principal part of which I have furnished a translation above. The next one is the provisional specification of the English patent, dated December 18, 1868. The next one is in the Berichte der Deutschen Chemischen Gesellschaft zu Berlin, January 11, 1869, of which deponent herewith renders a translation of the whole article:

"C. Graebe and C. Liebermann on Artificial Formation of Alizarine.

"About a year ago we apprised the Chemical Society of the first results of an investigation which we had undertaken in order to clear up the doubts about the chemical structure of alizarine. We had found at that time that alizarine is a derivative of anthracene. The question of the composition of this dyestuff was decided thereby, and we were enabled, on the basis of theoretical observations, to lay down a rational formula for the same. Therewith was made the first step towards the arriving at the artificial production of alizarine.

"We have now been successful in solving this second problem; we have produced artificially alizarine from anthracene. The properties of the product obtained by us, as also the colors which we obtained therewith on mordanted cotton, prove conclusively the identity of the artificial alizarine with that of the madder root. We submit to the inspection of the society samples of the sublimed artificial dyestuff as well as patterns of calicoes dyed therewith. The methods by which we arrived at the above-mentioned results, and which we will describe hereafter, confirm the correctness of the rational formula which we formerly laid down for alizarine.

"Of what importance our discovery will prove to be for the madder industry if it can be made successfully available for technical purposes, we need not point out particularly. The enormously large

consumption of madder in calico print works, the large tracts
373 of fertile lands which are necessary for its cultivation, show sufficiently clear the importance which a new branch of industry would obtain which would be based on the artificial production of alizarine from one of the substances of coal-tar oil."

[Here should follow the letter of Liebermann to the Society de Mulhouse, which was accidentally omitted here, but is printed on p. 4, folios 16 and 17, of this affidavit. Signed Wm. Pickhard. Signed R. E. S., U. S. Com'r.]

The next publication is in the same journal, p. 332. Deponent furnishes a translation of only a part of this article, leaving out the descriptions of certain processes mentioned therein:

"C. Graebe and C. Liebermann.—On Artificial Alizarine.

"Since the contents of our French patent have become public we believe that we should not wait any longer to make the Chemical Society acquainted with our process to produce alizarine from anthracene, and therewith supplement our short notice of the 11th of January of this year. We shall, however, do this only in general terms, as we reserve the experimental details and analysis for an exhaustive treatise, which will appear soon.

* * * * * * * * *

"Already in our first notice we pointed out that we had found no differences between natural and artificial alizarine; that the so very characteristic colorings which develop on cotton mordanted with alumina and iron are completely identical. We believe, therefore, that we have to deal with one and the same chemical individual, and not with isomeric compounds, of which an extraordinarily great number is supposable, and of which chrysophanic acid is an example, as we have already proved.

"We will point out in closing that our bringing forth of alizarine is the first example of the artificial formation of a dye-stuff of the vegetable kingdom."

Deponent says that by what Graebe and Liebermann described in the above quoted article—

"That the so very characteristic colorings which develop on cotton mordanted with alumina and iron are completely identical"—

they wished to convey the idea that the alumina mordants developed with a red color, and the iron mordant with a purple color, and both were fast against soaping; that Charles Graebe, one of the inventors of artificial alizarine, informed deponent of this during their interviews spoken of in his affidavit in this case, dated November 18, 1878.

Deponent further says that the treatise spoken of in the last article is the following:

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* * * * * * * * *

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Deponent further says that the treatise spoken of in the last article is the following:

374 "Annalen der Chemie und Pharmacie, Leipzing und Heidelberg, 1870, (pages 257–322,) on anthracen und alizaren. Von C. Graebe und C. Liebermann."

In this article they mention, on pp. 300, 303, processes by which they obtained artificial alizarine from bibromanthrachinone in the same manner as described in the patent, and then say:

"Filter the dark violet solution, and precipitate by addition of an acid. The alizarine separates in flocks, which appear often light yellow-brown, but also sometimes dark brown.

"After the washing, purify it either by crystallization from alcohol or, better, by sublimation. The alizarine is easiest sublimed by the method recommended by Schultzenberger. The dry substance (at most 1 grm.) is brought in a broad porcelain tile of 5 to 6 cm. height.

* * * * * * * * *

Then follows a description of the properties of this pure alizarine, purified as above recommended, and an analysis of the same, and then remarks on bichloranthrachinone and monobromanthrachinone, and then follows:

"A similar oxidation seems sometimes to lead, in a limited manner, to the formation of purpurine." * * *

In the "*Neues Handworterbuch der Chemie*," Braunschweig, 1871, edited by Dr. Hermann von Fehling, which is a chemical dictionary, as its title indicates, there is on pp. 235, 237 a chapter headed:

"Alizarin Lizarinsaure, Krapproth, matiere colorante rouge."

From this chapter Prof. Chandler has quoted several times, and says that it is written by Graebe, one of the inventors of artificial alizarine; it seems to be an abridgment of the article just quoted by me from the "*Annalen der Chemie und Pharmacie.*" On p. 236 is found:

"From anthracene, alizarine can be obtained by fusion of its chlorine and bromine derivatives; also from sulpho-acids of anthrachinone. The latter are the most suitable for the purpose. * *

Then follows the description of processes, and then—

"The whole mass is then digested with acid, and the separated yellow or brown-yellow alizarine well washed. It is intro-
375 duced into commerce the same as that obtained from madder in the shape of a paste or powder.

"Chemically pure alizarine is obtained by sublimation of the pure, after E. Kopp's method prepared madder extracts or of artificial alizarine. It is most suitable to bring small quantities in a porcelain tile of 50 gramm. capacity, covering this with a sheet of paper, and then with its coverlid, and heating its bottom on a sand bath to 250°. Also by repeated crystallizations from alcohol can the commercial products be purified."

After that time no publications of Graebe and Liebermann were found on this subject until their treatise "on the Vienna exhibition

of the year 1873." From this treatise deponent has quoted in his affidavit in this suit, dated November 18th, 1878.

Deponent says that of the many hundred chemists who had great interests in artificial alizarine, only those three mentioned above (Perkin, Auerbach, and Schunck) took the trouble to dissect Graebe and Liebermann's dyestuff; at all events, no other publications are found than theirs. The scientific researches of Rosenstiehl, E. Ullrich and K. Von Perger, Caro, Glaser, Liebermann, etc., cannot be considered as such dissections as Perkin made of artificial alizarine. They relate to the properties of some of the substances which form while fusing the oxidized anthrachinones with water and alkalies. Of the hundreds who use it daily in their factories not one has done anything of the kind, but did very much the same as William Bogle expresses it characteristically in his affidavit in behalf of defendant Cummins:

"In producing any particular tint it is necessary to select a variety of artificial alizarine, and I have had to mix three or four different kinds of artificial alizarine in order to produce the tint which was desired."

But the different manufacturers, in order to suit their customers for certain tints in vogue, tried to accommodate them, and strove hard to produce such artificial alizarine which suited best for the particular purposes; and in order to do so they, of course, investigated by which of the dyeing principles of their product it could best be obtained, and then to enlarge the percentage of that particular element in their dyestuff.

At first each manufacturer made only one grade of artificial alizarine for use in dyeing and printing. This grade of complainant has held its ground in this country until lately; it contains probably 60 parts of isomeric purpurines in its composition, and is admirably adapted for heavy styles of calicoes. It is only lately since the red cardinal color has come so much into fashion that the consumption of the grade with which this particular shade of color can be
376 easier produced, and which has probably 85 parts of the isomeric purpurines in its composition, has materially increased, and the consumption of that grade which was first introduced has been overreached by the other.

A good while after the beginning of the production and use of artificial alizarine the manufacturers commenced to separate and to offer artificial alizarine for blueish shade or for reddish shade. As this suited the consumers for special purposes, the producers strove hard to increase the separations for these particular shades. Some producers succeeded better than others with the separations, but it took them all a long while to come to such perfection as is attained to-day, and not until within the year 1876. Even to-day not one of the numerous manufacturers is able to furnish certain grades which approach in brilliancy and beauty those which complainants furnish.

In this wise the printers and dyers have learned to ask for blueish shade, medium shade, reddish shade, and yellowish shade of artificial

alizarine, just as the trade required certain shades to suit the fashion. None of them care for the names isopurpurine, anthrapurpurine, flavopurpurine, which scientists have applied arbitrarily to certain coloring principles which have been dissected from the dyestuff. They certainly never have asked for any such things or mentioned them in their orders within the experience of deponent, and that is from its first introduction until now.

Deponent further says that bromine was, in 1869, a very expensive article to use as a reagent on a manufacturing scale; besides that, bromine is a very disagreeable substance to use for such purposes, as Graebe and Liebermann very properly explain in their application to the Prussian government for a patent, in the year 1869, and which I have quoted in my other affidavit in this suit.

The statements of Prof. Chandler in his affidavits deponent understands as meaning to convey the idea:

That artificial alizarine could not be manufactured on a large scale by the use of bromine, and that this use of bromine is the essential feature of the whole method described in the patent of Graebe and Liebermann.

Deponent says that there is no difficulty whatever in carrying out Graebe and Liebermann's process in using bromine for manufacturing artificial alizarine on a large scale. At the time when the invention of Graebe and Liebermann was put into practical operation the thing which concerned them and those associated with them most was not whether it could be produced, because that was positively established, but whether they could produce it cheap enough to be able to compete against the former.

Deponent says that chlorine is largely used by complainant,
377 by Perkin, and his successors in the factory, and is also now used, as deponent is informed, in the factory with which Carl Rumpff, one of the defendants in this suit, is associated. It is particularly employed for the manufacture of artificial alizarine which is intended shall contain a very large proportion of the isomeric purpurines.

Deponent replies to the assertion of Prof. Chandler in his affidavit in this suit—

"Certain it is that Graebe and Liebermann never intended by their bromine process to produce iso-purpurine, anthro-purpurine, and flavo-purpurine, or either of them"—

that it is certain that Graebe and Liebermann intended to produce by their bromine and chlorine processes a useful and fast dyestuff; and that they used for that purpose the proper means.

If there should be a skeptic doubting the result of the means employed by Graebe and Liebermann, he could easily ascertain, if he were desirous of finding out the truth, by earnestly making a test; the process is a simple one, as can also be seen by the remarks of Edward Schunck in 1871, quoted in this affidavit.

Deponent further says that the translation and inferences of Prof.

Chandler, in his affidavit in this suit, of a letter of Liebermann, dated November 16, 1875, are wrong.

The contents of the letter conveys to deponent the idea to mean, that anthra or iso-purpurine are, of course, formed, although not in very considerable portions. The German word "allerdings" expresses the meaning "of course," "to be sure," "a matter of course," "certainly" when applied in this sense, "naturally," and the German expression, "Nicht gerade beträchtliche Mengen," certainly excludes the meaning "much." To any one who is acquainted with the subject and has made the tests of which Liebermann speaks afterwards in the letter, the tenor of the meaning of the above-quoted sentence is very clear; it means that not large portions are in it, such, for example, as there are in some of the commercial preparations of which those intended for reddish shades contain at least 75 per cent., and some even more of the isomeric purpurines, while those intended for blueish shades contain about 30 per cent. After treating the quantity on which he was operating, three times, for the purpose of extracting the anthrapurpurine from it, there was still some left in it; by dyeing with the product which he previously had well washed, which means that the easily soluble parts of the
378 dyestuff had been removed thereby, the colors developed showed plainly the presence of anthrapurpurine. These tests are the qualification of his assertion in the first sentence, and to any one acquainted with the making of such tests they clearly show that there could not have been a *small* portion of the purpurines present.

Deponent further says that he finds at the end of the affidavit of Prof. Chandler in this suit—

"I have examined one of these brands, such as is sold by T. K. Cummins & Co., and is known by them as brand No. 1. I have experimented with two hundred grammes of it—nearly half a pound. It has taken me more than three months to determine whether this sample contained any other dyestuff but alizarine, and, with such experience as I have to-day, it would take me at least two months to determine whether another similar sample contained any other dyestuff than alizarine. This process of determination is very long, owing to the necessary method, which, to a great extent, consists in tedious filtrations and washings. * * * In making this experiment * * * I have obtained from this half pound of artificial alizarine, brand No. 1, one-tenth of one per cent. or a thousandth part of the original material, which may or may not contain isopurpurine; but I see no reason to think that this one-thousandth part of my sample does contain isopurpurine."

By which deponent understands Prof. Chandler means to convey the idea that he obtained by his experiment one-tenth gramme of a substance which he does not know, and that the retained part of the two hundred grammes on which he operated, *i. e.* 199$\frac{9}{10}$ gr. which were left over, were alizarine chemically pure.

Deponent says that the one-tenth gr. had, however, very probably been dried by Prof. Chandler before weighing, for if there had been

any water left in it the statement of its weight would have been extremely indefinite.

Deponent saw and read Prof. Chandler's affidavit on Thursday afternoon, November 21st, and on the next morning went to the office of C. Howland, clerk of T. K. Cummins & Co., who states in an affidavit in this suit, dated November , 1878, that he furnished Prof. Charles F. Chandler with a sample of brand No. 1 artificial alizarine, and asked him to furnish deponent with a specimen of the same as he had furnished Prof. Chandler with; that on the next day, November 23d, deponent received from Mr. Howland a bottle containing about half a pound of a substance in the state of a thick, moist paste; the bottle was marked, "No. 1 Alizarine, T. K. C. & Co." After receipt of this bottle deponent handed the same
379 unopened to Carl Pickhardt, and caused, at once, a test to be made for determining its moisture, and it was found that it consisted of 11 per cent. dry material.

Deponent says that as Prof. Chandler's sample was the same as deponent's, his 200 gr. were in reality only 22 gr. of dry substance; this reduces his 1-10 gr. to 1-220 per ct. in place of 1-1000 per ct., as Prof. Chandler says, provided of course that he worked definite enough and dried his 1-10 gr.

Deponent says that Prof. Chandler asserts it took him a long time, "more than three months," for determining "whether this sample contained any other dyestuff but alizarine." It took deponent's assistant about two hours for determining that the substance was *not* alizarine chemically pure, and a few hours more for determining that it contained a notable quantity of purpurines; with these was dyed prepared cloth with a beautiful fast scarlet on the alumina mordant.

Deponent says that if Prof. Chandler had a faint knowledge of the usages with dyestuffs he would naturally have dyed first of all things with the substance furnished him; a comparative dyeing test with it, and with alizarine chemically pure, and with artificial alizarine, such as Cummins' brand No. 2, mentioned by C. Howland in his affidavit as being "used for reds and purples," would have been in order. This test would have revealed to him a great difference in the colors obtained with each. For corroboration, and for further testing, a chemical test might have been applied. For this purpose a very good test on artificial alizarine is the one devised by his co-laborer in this suit, G. Auerbach, and published in the January (1872) number of the *Moniteur Scientifique*, of which, on p. 44, the last paragraph commences: "Fifty grammes of alizarine paste are to be dissolved in a corresponding quantity of caustic soda solution." This test is recommended for these purposes by Edward Schunck and by Charles Liebermann. Prof. Chandler in his affidavit in this suit, on p. 38, speaking of Mr. Liebermann, says:

"He might equally as well have followed the direction of Auerbach for discovering whether iso-purpurine was formed."

If Prof. Chandler had applied this test and repeated the operation, say three times, he would have found in an extremely easy manner that the substance he had under treatment would have diminished considerably, and that on the other hand he would have obtained, in a notable quantity, another substance, provided he had not washed them away; that the diminished substance under treatment would not have been alizarine ch. p., but required further treatment; but that if he had made dyeing tests with this diminished substance he would have found that the alumina mordant would develop in a blueish dull red, but that the iron mordant would develop in a beautiful purple, and that the colors would be fast; and if he had made dyeing tests with the substance which he extracted from it,
380 which he should have done as a careful expert, he would have found colors developing on the mordanted cotton which had hardly any semblance at all to the others, but they would have been also fast; the alumina mordant would have developed into a scarlet, while at the same time the purples would have been slaty—similarly as Camille Koechlin described the colors which he obtained with artificial alizarine on the one hand, and with purified alizarine from madder on the other, in the *Moniteur Scientifique*, Paris, 1869. Prof. Chandler would then have known positively that the specimen furnished to him by Howland was not alizarine chemically pure, but had other useful dyestuffs in its composition

All these tests would not have taken Prof. Chandler more than two days.

Deponent says that Prof. Chandler should, in order to make his statements of his tests intelligent to those not acquainted with such operations, have mentioned that the 198 9-10 parts of the material on which he operated were washed and filtered away by him, and that if he had gone on a little longer he would not have had left anything at all; but that in order to be able to make certain statements, something had to be saved. This something is unknown to Prof. Chandler; he could have found out very quickly what colors it dyes by making the test. With ¼ of the 1-10 gr. which he had left he could have dyed a piece of prepared cloth of the size of 4 in. by 8 inches, such as is usually employed for such purposes, with deep full colors. Prof. Chandler ought to have made occasionally, within the three months that he was operating, dyeing tests with the substances which he washed away; as a conscientious expert he would have collected some now and then and tested them; even these tests would have revealed to him clearly that the substance furnished him, and carefully prepared for the purpose, contained "other dyestuff than alizarine."

WM. PICKHARDT.

Sworn to and subscribed before me this 2d December, 1878.

R. E. STILWELL,

U. S. Com'r for Southern District of New York.

381 U. S. Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE, HUGH COCHRANE, and CARL RUMPFF. } In equity.

CITY AND COUNTY OF NEW YORK,
Southern district of New York, } *ss.*

HENRY MORTON, being duly sworn, deposes and says:

I have already made an affidavit in the present case.

I have read the affidavit (translation) of Dr. P. Roemer; also the affidavit (translation) of Dr. E. Schüler, which appear to be duplicates of each other. I have also read an affidavit (translation) by Gustav Auerbach, which seems to be identical in substance with the foregoing, all entitled in this case. The first two of these open with a declaration "that it is possible to make alizarine according to the so-called bromine process, (patent of Graebe and Liebermann,) which is pure and free from by-products," and then proceed to describe, step by step, the method which they suggest might give the above-named result.

In this description I find that in place of preparing bibromanthrachinon, as directed by the patent, they prepare *mono*-bromanthrachinon, and in place of fusing the *former* with castic potash and water, as directed in the patent, they fuse the *latter* "with caustics and strongly oxydizing substances, such as chlorate of potash.

Supposing that by this means they might obtain the result they mention, it evidently fails utterly to support their suggestion that the process patented by Graebe and Liebermann, which they have carefully avoided to follow, would produce any such result.

Mr. Auerbach in his affidavit makes no mention whatever of the process of Graebe and Liebermann, and thus avoids the above gross absurdity; but this omission, as it seems to me, cuts it off from any reference, even the most remote, to the present case.

I have also read the affidavit of Dr. Charles F. Chandler in
382 the present case, in which he says that after six months' labor he has only now succeeded in making from a quarter of a pound of bibromanthrachinon a teaspoonful of alizarine product.

As I have never found any difficulty in making a teaspoonful of alizarine product in the course of a few hours and from a few grammes of bibromanthrachinon, I cannot but regard the *smallness* of Dr. Chandler's product as the result of the immense ingenuity and vast time spent in securing it. Where success is so easy it is but natural that much labor might be required to achieve so decided an ill-success.

Since my previous testimony in this case I have worked with considerable quantities of bibromanthrachinon, and have obtained not "a few grammes," but half a pound or so of artificial alizarine, corresponding in all respects with what I had before found in the smaller quantities.

When Dr. Chandler says that he knows of no authority with whom I am in accord in my opinion as to the relations of anthra, iso, and flavo-purpurine, he very frankly acknowledges his want of familiarity with the recent literature of the subject, as all my conclusions are fully supported by the researches of Rosenstiehl, contained in the "Bulletin de la Societe Chemique de Paris" for May 5th and May 20th, 1878, to which I have alluded in my answer to re-d. q. 214, p. 104, folio 472, in the Cummins suit.

In reference to Dr. Chandler's statement that he was able to obtain from certain alizarine, brand No. 1, no more than one-tenth of one per cent. of "something which may or may not contain isopurpurine," I would remark that there is no evidence to show that the alizarine on which Dr. Chandler worked had not been treated, to remove isopurpurine, &c., before he received it.

Second, that the process for the separation of isopurpurine, &c., causes great loss of that substance, especially in the hands of one not experienced in the behavior of these substances, and who therefore does not know when to stop the successive washings, &c.

In reference to Dr. Chandler's statement that it has taken him three months to try to determine whether a certain brand of artificial alizarine contained any other dyestuff than chemically pure alizarine, and that it would take him two months more to reach the same conclusion (?) with another sample, I have only to say that I took a sample of what I believe to be the same artificial alizarine, brand No. 1, operated upon by Prof. Chandler, which was given to me by Mr. Carl Pickhardt, and in the course of a few hours not only found it to contain a dyestuff other than chemically pure alizarine, but extracted enough of the same to dye the swatch on the annexed card marked "Morton Exhibit S," which, by the color of the parts prepared with alumina mordants and its resistance to soaping, shows that this
383 material is not alizarine, but something agreeing essentially with the descriptions given of the isomeric purpurines, anthrapurpurine, and flavo-purpurine.

The same extracted dye-stuff, by its color in alkaline solution (see annexed tube, Exhibit Morton T) proves the same thing.

I should, moreover, have no hesitation in saying that within the same time I could decide the same question as to any other sample of alizarine which was submitted to me.

Deponent further states that he has read the affidavit of G. Auerbach, (see p. 7,) and in reference to the same would say:

1st. That it is quite true that he regarded Mr. Auerbach as an authority on the subject of the substance called by him isopurpurine, and many other matters, up to the time when he read Mr. Auerbach's affidavit of March 25th, 1878, but that the gross ignorance on matters of chemical principle, and in reference to the literature of alizarine, &c., displayed in said affidavit, lead him to doubt the soundness of his own conclusion in this respect, and that further study and experiments confirmed this doubt, and have convinced him that Mr. Auerbach was mistaken when he thought that he had

isolated a new body from artificial alizarine, in what he called isopurpurine, but that the substance which Mr. Auerbach really obtained was a mixture of anthrapurpurine, separated two years before by Perkin from artificial alizarine, with flavo-purpurine and some alizarine. These conclusions have been fully confirmed by a research recently published in the Bulletin de la Societe Chemique de Paris, 1878, p. 400 et seq.

Several foreign writers have fallen into the mistake of overlooking the earlier publications of Perkin in 1870, and have thus given Auerbach a credit which he does not deserve, but their mistakes cannot affect the publications that were made by Perkin in 1870, and in May, 1872, and that Auerbach's first publication, which was not till July, 1872, was thus anticipated by two years in one case and by two months in another.

Very probably he did not know of these prior publications until I pointed them out; but that does not affect the question of their existence, but only shows how little he knew about the literature of the subject.

What Mr. Auerbach calls personal attacks, to which he does not intend to reply, will, on examination, be found to contain nothing whatever personal, but simply to refute certain false or ignorant statements in Mr. Auerbach's affidavit.

I nowhere admit that pure alizarine can be made from anthracene in any such sense as Mr. Auerbach implies in his affidavit, but only that after the new dye-stuff artificial alizarene has been made, pure alizarene may be separated out from it as it may be from madder extracts.

In reference to what Mr. Auerbach has to say about my ability to distinguish cloth dyed by natural from that dyed by artificial
384 alizarine, (folios 28, 29, 30,) he is only arguing from his own ignorance as to what I can do. He is entirely in the dark as to my methods of testing, and so fails to understand my results.

At folio 31 Mr. Auerbach again confuses himself through his own stupidity. My statement about temperature and quantity of alkali as affecting the character of the product does not carry any such meaning as he supposes, and is, therefore, not touched by his criticism.

As to the graphical formulæ of anthracene, anthrachinone, &c., used by me, I know perfectly well that their particular arrangement was not according to the latest theory, but was used by me as most distinct and easy of expression, the difference involving nothing but a slight change of relative positions of the parts which had no significance in reference to the points under consideration. In referring to rufigallic acid as an illustration in my cross-examination, I forgot that besides the hydroxyls which I spoke of it had two atoms also of oxygen more than alizarene. This was an oversight which, however, did not in any way affect the force of my illustration. Had I remembered this point I simply should have added it to the rest of the statement.

Deponent further says: I have treated a sample of artificial alizarine (given to me by Mr. Carl Pickhardt, and said to be made by Bayer & Co. and sold by A. Cochrane & Co., and marked "Artificial Alizarine No. 1") in the same manner as the above-mentioned specimen, brand No. 1 of Cummins, and obtained from it a dyestuff, not pure alizarine, of which exhibit marked "Morton Tube U" is an alkaline solution, and with which the swatch marked "Morton Swatch Exhibit V" is dyed.

Deponent further says: I followed the process described in the affidavits of Messrs. P. Roemer, E. Schuler, and G. Auerbach, except in so far as they varied from the directions given in the patent of complainants, and in place of obtaining pure alizarine I got a product from which I extracted a dyestuff other than alizarine, of which exhibit marked "Tube Exhibit Morton W" is an alkaline solution, and with which swatch marked "Exhibit Morton X" is dyed.

HENRY MORTON.

Subscribed and sworn to before me this 2nd Dec., 1878.

R. E. STILWELL,
U. S. Com'r for southern district of New York.

385 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, CARL RUMPFF. } In equity.

CITY OF BOSTON, DISTRICT OF MASSACHUSETTS, *ss.*

JOHN M. ORDWAY, being duly sworn, deposes and says:

That he made an affidavit in this suit dated November 14, 1878, and he hereby confirms the same.

Deponent further says that he has read the affidavits made in this suit (translations) of Dr. P. Römer, dated August 5, 1878, Dr. E. Schüler, dated August 5, 1878, which are copies of each other, and Gustav Auerbach, dated August 22, 1878; that the processes described therein are the same. Deponent further says that it appears from said affidavits that the respective affiants have set forth therein a series of operations which they assert will, if followed, give, as an end product, pure alizarine, by which term deponent understands they mean alizarine chemically pure; that said series of operations is not described in the letters patent of Graebe and Liebermann, reissue No. 4,321; that said affiants nowhere state in their affidavits that they have made chemically pure alizarine by the process or series of operations described by them in their affidavits, but simply suggest that it might, in their opinion, be made by following said series of operations, and yet they say:

"The alizarine thus obtained is perfectly pure and free from by-products, $C_{14}H_8O_4$. It is identical with natural alizarine prepared

from madder, and it is employed in dyeing and print works with the same effect as this."

This last statement clearly implies that this alizarine is made on a manufacturing scale by a bromine process, and that the product is in use among dyers and printers; but the affiants further say:

386 "The bromine process was rejected by the alizarine makers after the first trials as perfectly useless for the manufacture of alizarine on a manufacturing scale."

Deponent further says that, in his judgment, these statements are irreconcilable, and that the affiants have, in their affidavits, given merely their opinions, and not accounts of actual experiments.

Deponent further says that he has read the affidavits made in this suit (translations) of A. Viehaus, Adolph Gaube and August Roemer, and does not find therein any intimation that they have subjected dyed specimens to tests for their fastness; that deponent has himself taken threads from the samples of yarn dyed with artificial alizarine and garancine annexed to the affidavit of Roemer, and found that they are by no means equally fast; that he tested them with ferrocyanide of potassium and caustic soda, and found that the sample of yarn purporting to be dyed with garancine nearly faded away under this test, while the sample purporting to be dyed with artificial alizarine withstood the test, and deponent annexes hereto the same samples on which he made said test.

Deponent further says that he has read Prof. Charles F. Chandler's affidavit in this suit, dated November 20th, 1878, which affidavit is made up mainly of negative evidence. Prof. Chandler therein acknowledges that he has worked six months and yet has been unable to obtain from a quarter of a pound of bibromanthrachinone more than a teaspoonful of artificial alizarine paste; that he considered this too small a quantity for further investigation, and that he has not succeeded in proving that there is no isomer of purpurine in the products of the bromine process Deponent says that he himself, having at command a very simple and inexpensive apparatus made for the purpose, has, during the present month, prepared not less than ten ounces of artificial alizarine paste, rich in coloring matter, from about two ounces of bibromanthrachinone, according to the process described in said reissued patent No. 4,321, and that he made the same in a few hours. Deponent further says that he has assisted at the performance of another experiment with two ounces of bibromanthrachinone, and has examined the product.

Deponent further states that, as a chemist and as an experimenter, who has actually carried on the process and examined the end product, *he does see reason* to believe that some other dyeing substance besides chemically pure alizarine is *necessarily contained in* said end products; that he made dyeing tests therewith, and obtained colors different from those produced by chemically pure alizarine with the same mordants.

Deponent understands Prof. Chandler to declare, after saying that

he understands Prof. Morton to have come to the conclusion that anthrapurpuine is one thing and flavopurpurine is another
387 thing, that he knows "of no authority with whom Prof. Morton is in accord." It is only necessary for Prof. Chandler to refer to the Journal of the Chemical Society of London, vol. xiv, part 1, p. 299, to find a tabulated statement by which Schunk and Roemer show plainly, by the numerous differences in the reactions, that anthrapurpurine is one thing and flavopurpurine is another thing.

Prof. Chandler says he has examined a specimen of artificial alizarine obtained by him from T. K. Cummins & Co., marked No. 1, and that he has found no anthrapurpurine or isopurpurine in said sample, but there is no intimation as to whether this was the crude end product, artificial alizarine, or some substance which had been subjected to some subsequent treatment after the fusion or melt with alkalies.

And, further, Prof. Chandler's negative result cannot be considered as by any means proving the absence of the isomers of purpurine, for he speaks of only one process of separation, and there is another method known to be more effectual.

Deponent further says that he has read the affidavit of Charles Hunter, dated August 29th, 1878, wherein said Hunter gives only hearsay evidence, and to which he appends specimens of Turkey red cloth, which he did not himself dye or cause to be dyed. The affidavit states that he "has always been informed that the coloring principle of madder is the same as the coloring principle of alizarine from anthracene; that the same shades can (be) and are obtained with madder derivatives and alizarine from anthracene." But he was also informed by Mr. Kerr "that for some styles, where a full red shade was required, they had obtained better results with madder than with alizarine made from anthracene, but yellow shades could not be produced so well with madder as with alizarine from anthracene." Thus the affiant's items of hearsay evidence do not appear to be quiet consistent with each other. The deponent notices that this second-hand testimony relates throughout only to hues and shades, and takes no account of the fastness of the colors.

JOHN M. ORDWAY.

UNITED STATES OF AMERICA, }
District of Massachusetts. }

Subscribed and sworn to before me, this day of December, 1878.

JOHN G. STETSON,
U. S. Commissioner.

388 United States Circuit Court, southern district of New York

BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE, HUGH COCHRANE, AND CARL RUMPFF. } In equity.

CITY, COUNTY, AND STATE OF NEW YORK, *Southern district of New York,* } *ss.*

ARNO BEHR, being duly sworn, deposes and says:

That he resides at Jersey City, N. J., and is the chemist for F. O. Matthiessen and Wiechers Sugar Refining Company at that place; he further says, I have read the affidavits of Messrs. Roemer, Schueler and Auerbach, as originally made in German, and find that, beginning from where the translations read, "having been requested," and "having been asked," respectively, to the end, they are verbally identical, with the one exception, that in this first sentence, "having been requested to give my opinion whether it be possible to make alizarine according to the so-called bromine process (patent Graebe and Liebermann,") in Mr. Auerbach's affidavit, the words ("patent Graebe and Liebermann,") are suppressed. While, therefore, Messrs. Roemer and Schueler leave no doubt that what they understand under the "so-called bromine process," is the process described in Graebe and Liebermann's patent, Mr. Auerbach seems to have felt that the difference between the process he says he followed for the production of pure alizarine, and the process of Graebe and Liebermann for the production of artificial alizarine is too great to allow any such identification. To see this difference, it is only necessary to follow the different steps in the two processes through their several products.

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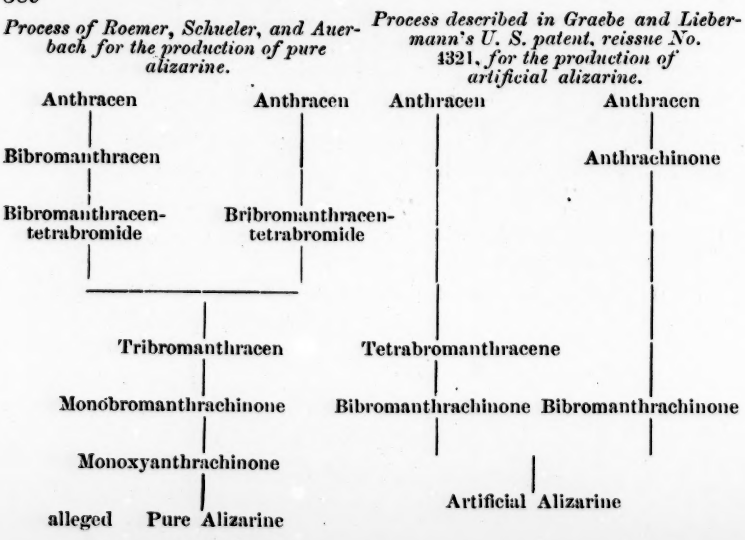


Roemer, Schueler, and Auerbach use a substance (monobromanthrachinone) which, in the fusion with alkali, produces monoxyanthrachinone in the first instance, while Graebe and Liebermann use bibromanthrachinone. A chemist, if asked which substance is more likely to produce isopurpurine, would say that it is the latter, which, by the action of alkali, must take up at least two hydroxyls, and might take up one more, while the first only takes up one directly and the second is introduced in a different way. In connection with this I will say that I differ with Prof. Chandler in his opinion as expressed in his affidavit, that, as a chemist, he sees no reason to believe that any of the isomeric purpurines are produced in any appreciable quantity by the bromine process of Graebe and Liebermann. In my opinion it is highly probable that in this process, besides alizarine a coloring substance of the composition of purpurine is produced, and I find that Graebe and Liebermann were of the same opinion in 1870, when they say in their extensive paper on anthracen and alizarine, (Annalen der Chemie und Pharmacie, supplement VII, p. 303,) after speaking of the transformation of monobromanthrachinone into alizarine in the melt, (translated:)

"It seems that sometimes a similar oxydation in the melting of bibromanthrachinone with caustic potassa leads, in a small measure, to the formation of purpurine, but we have, so far, not been able to prove it with absolute certainty."

This shows that they saw, as early as 1870, that the product from bibromanthrachinone contained some coloring matter different from alizarine. This being known to Messrs. Roemer, Schueler, and Auerbach, when they wished to describe a process by which alleged pure alizarine might be produced, were very careful not to follow the directions of Graebe and Liebermann's patent. Instead of making tetrabromanthrachen they make tribromanthracen; instead of bibromanthrachinone they make monobromanthrachinone, and this substance before becoming alizarine has to undergo a previous transformation into monoxyanthrachinone. Besides, in the melting process with caustic alkali, they have to add an oxydizing agent, a thing which is not mentioned at all in the patent. Notwithstanding these differences, those three experts assume that the entire products of the two processes, as followed by them and as described in the patent, are identical, while only a most thorough investigation could convince any chemist of such an identity. They have not attempted to prove this identity, and the only explanation why they did not do it nor use the process of the patent, seems to me to be that they knew that the product of the patent process was not pure alizarine.

So far I have assumed that Messrs. Roemer, Schueler, and Auerbach, in describing a process for the production of pure alizarine, wished to be understood that they had actually carried out this process; but there is a doubt in my mind if they really did so. The wording as given originally in German admits of another interpretation. The question being if it be possible to produce pure alizarine

according to the bromine process, they could either testify that they had carried out the process and obtained the product which they found to be pure alizarine and nothing else, or they could testify that they believed that by following a certain process a product would be obtained of the properties of pure alizarine. If they intended to leave it doubtful in what way they really wished to testify they could not, in my opinion, have chosen a better expression than they have actually given. They do not swear that in order to accomplish a certain result they *have done* certain things and *have obtained* certain products, but by their wording leave room for the supposition that the process they describe is only a proposed one. The English translation needs correction in an essential point. The passage which in Roemer and Schueler's affidavits reads "and it" (their alleged product) "*is employed* in dyeing and print works with the same effect," would imply that this product is actually manufactured on a large scale and used in dye and print works. The German original leaves the question of its commercial manufacture and use open, and is better rendered in the translation of Mr. Auerbach's affidavit, which reads: "and has, in its application to dyeing and calico printing, exactly the same effects." When these gentlemen speak of their final product, and assert "the alizarine obtained in this manner is perfectly pure and free from by-products, C_{14}, H_8, O_4," they do not give any proof of their assertion. Yet, as this is the principal point,
401 such proof ought to have been given.

What satisfied them might not satisfy others, and it is customary and very easy for chemists to substantiate assertions about the nature and properties of a certain substance by citing the analytical results which they have obtained, and qualitative tests which they have made.

ARNO BEHR.

Subscribed and sworn to before me this 2d day of December, 1878.

R. E. STILWELL,
U. S. Com'r for southern district of New York.

402 United States Circuit Court, southern district of New York.

BADISCHE ANILIN AND SODA FABKIK
vs.
A. COCHRANE, HUGH COCHRANE AND CARL RUMPFF. } In equity.

CITY AND COUNTY OF NEW YORK, } *ss.*
Southern district of New York, }

CARL PICKHARDT, being duly sworn, deposes and says:

That he made a previous affidavit in this motion; that he has read the affidavits in the suit "Badische Anilin and Soda Fabrik *vs.* T. K. Cummins," o Charles F. Chandler, Gustav Auerbach, Carl Otto Neuhaus and Carl Rumpff, also the affidavits in the present "Cochrane suit," of P. Röemer, E. Schüler, Gustav Auerbach, Charles F.

Chandler and C. Howland; that Carl Otto Neuhaus and Carl Rumpff in their affidavits state that when manufacturing artificial alizarine from anthracene they can produce, and do produce and sell alizarine perfectly pure, which is not "mixed with impurities, giving with alumina mordants yellowish reds, and with iron mordants reddish dull purples."

Deponent further says that he is informed and believes that the artificial alizarine referred to by said Neuhaus is that which is sold by his agent, T. K. Cummins, as brand No. 1, and that the artificial alizarine referred to by said Rumpff is that sold by A. Cochrane & Co. as No. 1—*Extra Bluish*, and that he has procured some of each of the said artificial alizarine referred to by said Neuhaus and Rumpff and which they in their affidavits describe "an alizarine perfectly pure and identical with alizarine prepared from madder root according to the formula $C_{14}H_8O_4$, and giving with alumina mordant a crimson red or pink, and with iron mordants a fine bright purple;" and that deponent examined the same and found upon investigation that he could extract and did extract from such "alizarine perfectly pure" coloring matters, which dyed alumina mordants a scarlet red and yellowish pink, and on an iron mordant a slaty purple.

403 That he has read the affidavit of Gustav Auerbach in the Cummins suit, wherein he finds the following:

"The alizarine made from *mono*sulfo acide of anthraquinone which dyes the most bluish tints of alizarine from anthracene, and *is used largely for dying and printing pinks and purple shades*—produces *chemically pure alizarine* and shows, when dyed or printed on cloth—*exactly the same properties and results—as pure alizarine from madder.*"

Here Mr. Auerbach states that the "alizarine made from monosulfo acid of anthraquinone" is not chemically pure alizarine, but that chemically pure alizarine can be produced from it.

That he has read the affidavit of Gustav Auerbach made in the Cochrane suit, as well as the affidavits of P. Roemer and E. Schüler, and deponent finds that they do not in the processes described by them in their affidavits follow the directions given in the patent of Graebe and Liebermann.

Deponent further says that he has made artificial alizarine according to the directions given in the patent of Graebe and Liebermann twelve times, and has always found that the yellow flocks which he produced thereby contain coloring matters which dye alumina mordants a scarlet-red and yellowish-pink, and iron mordants slaty-purples, and which coloring matters are always present in considerable quantities in the said product.

Deponent further says that he has read the affidavit of Charles F. Chandler in the Cochrane suit, and finds that Prof. Chandler must have striven very hard not to obtain artificial alizarine according to Grabe and Liebermann's patent, since he states that he was only able to obtain "what could be held in an ordinary teaspoon, from one-quarter of a pound of bibromanthraquinon." That deponent has made artificial alizarine from bibromanthraquinone according to the directions given

in the patent of Graebe and Liebermann, 12 times, as he has above stated, and never failed to obtain the yellow flocks of artificial alizarine in quantities; for instance, by taking two ounces of bibromanthraquinone, which is one-half the quantity that Prof. Chandler says he used, deponent obtained, as the final result, about five ounces of artificial alizarine paste, which contained at least 14.5 grammes of dry substance. That deponent made six of the said operations with two ounces of bibromanthraquinone at each operation, and always obtained about the same quantity, from which he made tests and separations on a comparatively large scale; the tests showed to deponent that the product so obtained contained large quantities of dyestuffs which dyed alumina mordants a scarlet-red and yellowish-pink, and iron mordants slaty purples, which corresponded to the descriptions of the isomeric purpurines as published by Perkin and others.

Depopent further says that he obtained from Wilhelm Pick-
404 hardt a bottle marked "No. 1 Alizarine, T. K. C. & Co.," containing about eight ounces of paste; from this paste deponent handed some to Prof. Henry Morton and he took another part for trial to determine its moisture, and found it to contain 11 per cent. of dry material. Deponent understands from the affidavit of Prof. Chandler that he obtained a quantity of the same substance, and that he says it took him "more than three months to determine whether this sample contained any other dyestuff but alizarine," and was not able to say whether it contained anything else but chemically pure alizarine, as he obtained something, only "a thousandth part of the original material, which may or may not contain isopurpurine." Deponent says that he dissolved of said Cummins alizarine No. 1 about two ounces in caustic soda solution, and treated the same by passing through the solution a current of carbonic acid; when a precipitate had formed the whole was thrown on a filter. The clear red liquor so filtered showed to deponent that the said alizarine of Cummins was not chemically pure by any means. This liquor was then neutralized with muriatic acid, when a precipitate formed, which was collected on a filter. The precipitate so obtained was carefully washed with water until the passing liquor did not show any longer an acid reaction. Dyeing tests were then made by deponent with this precipitate, which show a scarlet red and yellowish pink with alumina mordant and a dull purple with the iron mordant. The whole of this process and tests was finished in one day. While making the said separations and tests with said alizarine Cummins No. 1, deponent at the same time treated in the same way the same quantities of artificial alizarine No. 1 of F. Bayer & Co., and also of Meister, Lucius & Bruening, and also of Wilhelm Pickhardt and Kuttroff, agents of complainants; that is, samples of all artificial alizarine No. 1, which is sold in this country for producing fine purples and pinks, and he found that they all gave the same reactions, and that the extracts obtained from them dyed mordanted cloth with the same characteristic shades as the extract obtained from Cummins alizarine No. 1. This process of separating artificial alizarine was

first published in the *Moniteur Scientifique*, Paris, 1872, by Auerbach, who was working in the laboratory under Prof. E. Kopp, in Zurich. This method was also published by Liebermann and Troschke in the *Berichte der Deutschen Chemischen Gelleschaft*, Berlin, in 1875; and by Schunk and Roemer in the *Berichte der Deutschen Chemischen Gelleschaft*, Berlin, 1877.

Deponent has also submitted to this same process of separation artificial alizarine produced by himself from bibromanthraquinone, according to the directions given in the patent of Graebe and Liebermann, and found that large quantities of isomeric purpurines were separated, which dyed with the same char-
405 acteristic colors as the extract made from the alizarine, Cummins, No. 1; that is, the reds and pinks are very scarlet, while the purple is slaty.

Deponent further says that he hereto annexes a card, Exhibit No. 5, on which are fastened ten sealed tubes, whose contents are as follows:

TUBE A.—Solution of artificial alizarine, Cummins, No. 1, in bicarbonate of soda.

TUBE A′.—Solution of extract from artificial alizarine, Cummins, No. 1, in bircarbonate of soda.

TUBE B.—Solution of artificial alizarine No. 1, Meister, Lucius and Brüning, in bicarbonate of soda.

TUBE B′.—Solution of extract from artificial alizarine No. 1, Meister, Lucius and Brüning, in bicarbonate of soda.

TUBE C.—Solution of artificial alizarine No. 1, Bayer & Co., in bicarbonate of soda.

TUBE C′.—Solution of extract from artificial alizarine No. 1, Bayer & Co., in bicarbonate of soda.

TUBE D.—Solution of artificial alizarine No. 1, Badische Anilin and Soda Fabrik, in bicarbonate of soda.

TUBE D′.—Solution of extract from artificial alizarine No. 1, Badische Anilin and Soda Fabrik, in bicarbonate of soda.

TUBE E.—Solution of artificial alizarine produced by deponent according to the directions in the patent of Graebe and Liebermann, in bicarbonate of soda.

TUBE E′.—Solution of extract from artificial alizarine produced by deponent according to the directions in the patent of Graebe and Liebermann, in bicarbonate of soda.

Deponent also annexes a card, Exhibit No. 6, to which are attached twelve swatches of dyed mordanted cloth, dyed as follows:

SWATCH F.—With said Cummins alizarine No. 1.

SWATCH F′.—With said extract of Cummins alizarine No. 1.

SWATCH G.—With Meister, Lucius and Brüning artificial alizarine No. 1.

406 SWATCH G′.—With said extract of Meister, Lucius and Brüning artificial alizarine No. 1.

SWATCH H.—With Bayer & Co. artificial alizarine No. 1.

SWATCH H'.—With said extract of Bayer & Co. artificial alizarine No. 1.

SWATCH I.—With Badische Anilin and Soda Fabrik artificial alizarine No. 1.

SWATCH I'.—With said extract of Badische Anilin and Soda Fabrik artificial alizarine No. 1.

SWATCH K.—With artificial alizarine produced by deponent, according to the directions in the patent of Graebe and Liebermann.

SWATCH K'.—With said extract of artificial alizarine produced by deponent, according to the directions in the patent of Graebe and Liebermann.

SWATCH L.—With artificial alizarine produced by deponent in a second operation, according to the directions in the patent of Graebe and Liebermann.

SWATCH L'.—With said extract from the same.

Deponent annexes a card, Exhibit No. 7, to which are attached parts of each of the above mentioned twelve swatches, and which have been boiled in soap solution. They are marked respectively as the above, with the addition of the figure 2.

CARL PICKHARDT.

Sworn and subscribed to before me this 2d day of December, 1878.

R. E. STILWELL,
U. S. Com'r for southern district of New York.

407 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

Testimony of Henry Morton.

408 United States Circuit Court, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
vs.
THOMAS K. CUMMINS. } In equity.

EVIDENCE FOR COMPLAINANTS.

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States, in equity, as amended.

Before me, R. E. STILLWELL,
Examiner.

NEW YORK, *March 20th*, 1877.

Present—J. Van Santvoord, of counsel for complainants; C. C. Beaman, of counsel for defendants.

Before me, R. E. STILLWELL,
Examiner.

Deposition of Henry Morton.

Direct examination by counsel for complainants:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Henry Morton; age, 40 years; residence, Hoboken, New Jersey, and am president of the Stevens Institute of Technology of that place.

Q. 2. Have you given special attention to the subjects of chemistry and physics?

A. I have from my boyhood on. I have occupied the chair of chemistry and physics in the University of Pennsylvania, and have made many researches in these subjects, the results of which have been published in the scientific journals of this country and Europe.

Counsel for complainants puts in evidence a certified copy of letters patent of the United States, reissue No. 4321, bearing date April 4th, 1871, granted to Charles Graebe and Charles Liebermann, for an improvement in dyes or coloring matter from anthracine, and the same is marked "Complainants' Exhibit A, March 20, 1877, R. E. S., examiner."

409 Also a certified copy of an assignment of said patent by said patentees to the complainants, dated March 1, 1872, and of the recording thereof in the Patent Office March 28, 1872, in Liber I[15], page 260, of Transfers of Patents, and the same is marked "Exhibit B, March 20, 1877, R. E. S., examiner."

(Objected to as incompetent by counsel for defendants.)

Q. 3. Have you read the letters patent, Complainants' Exhibit A, and do you understand the invention therein described?

A. I have, and I believe that I do.

Q. 4. Look at the bottle and contents I now hand you, which is labeled as follows:

"Alizarine artf. C. II, obtained at Oriental Printworks, Feb. 10, '75.

"WM. PICKHARDT & KUTTROFF,
"23 Cedar street, New York,"

and state if you have had the same in your possession, and since what time, to what time, and from whom you obtained it?

A. I have had the same in my possession since the 13th of October, 1876, until a few minutes ago, when I gave it to Mr. Van Santvoord. I obtained it at the date specified from Mr. Kuttroff, at the office of Wm. Pickhardt & Kuttroff, corner of Church and Liberty streets, New York.

(Counsel for complainants offers in evidence the bottle and contents referred to in the last answer, and the same are marked "Complainants' Exhibit C, March 20, 1877, R. E. S., examiner.")

Q. 5. Have you examined any of the contents of Exhibit C for the purpose of ascertaining what the same is; and if so, state what you found the same to be; and state also how it compares as to similarity

or dissimilarity with the article described in and specified in the claim of complainants' patent, Exhibit A?

A. I have examined a portion of the original contents of said bottle by a variety of tests, and find it to be a specimen of artificial alizarine, corresponding in all respects with the product described in the patent, Complainants' Exhibit A, as alizarine, or artificial alizarine.

Q. 6. State some of the tests which you used in making that examination?

A. In the first place I took a portion of the contents of said bottle and dyed with it, in the usual manner, a piece of mordanted cloth such as is usually employed in such tests; the action in the dyebath, the colors produced and their change upon soaping, corresponded in all respects with the behavior under similar circumstances of the product produced by following the directions given in the patent Complainants' Exhibit A; I then dried and heated a small portion
410 of the contents of said bottle, Exhibit C, so as to obtain by sublimation crystals corresponding with those similarly obtained from the artificial alizarine of the patent; I then took a portion of the contents of the same bottle, treated it with excess of caustic soda solution, filtered and washed the undissolved material remaining on the filter, which I then dried and sublimed, obtaining long yellowish needles of anthraquinone.

To the soluble part or filtrate I added a solution of chloride of calcium in excess, so as to precipitate the coloring matter as a lime or calcium lake; I boiled the whole mass and then threw it upon a filter, whereupon there ran through a yellowish red solution; I repeated the boiling with fresh water, and again filtered and precipitated both the solutions, or filtrates, with hydrochloric acid; the precipitates yielded a yellow-brown material which was washed on a filter with pure water, dried and sublimed, when it yielded golden yellow flakes of monoxanthrachinone; the insoluble portion or lime lake on the filter was then removed and decomposed with hydrochloric acid, and washed to remove all the lime; it was then dissolved afresh in a solution of caustic soda and precipitated as a baryta lake by a solution of hydrate of baryta; this baryta lake was then boiled and thrown on a filter, whereupon there ran through the filter a reddish liquid, which being in its turn precipitated with hydrochloric acid, yielded yellowish flocks of isopurpurine, which were washed on a filter and then tested by a solution in caustic soda and in ammonia; in caustic soda the produced a solution of a characteristic reddish purple, and in ammonia a solution of an equally characteristic red inclining to orange.

These tests show among other things that the substance contained three bodies which are not found in madder root or its preparations, namely, anthrachinone, monoxanthrachinone and anthrapurpurine.

The first of these, anthrachinone, is the body used in the first step of the process described in the patent; and the second and third are products characteristic of the second step.

The entire body is shown by the other tests to possess the essential characteristics of the product described in complainants' patent Exhibit A.

Q. 7. What can you say respecting the novelty of the product which is described in and specified in the claim of complainants' patent Exhibit A?

(Objected to as incompetent.)

A. I consider the product to be novel in a variety of respects, among which I will enumerate the following:

In the first place, as a dyestuff it possesses new properties, being capable of producing under identical conditions, effects differing from and superior to those obtained from madder and its preparations; as a dyestuff it moreover admits of being applied in new ways, and
411 yields colors which are more fast, or resist the actions which tend to fade or destroy the color in dyed fabrics much better than does madder root or its preparations.

As a chemical substance it is new in its composition, containing notable quantities of anthrapurpurine, isopurpurine and other substances which do not exist in madder root or its preparations, and which are moreover important in their influence on the product as a dyestuff.

This product is, moreover, new in its method of production; it is developed from an otherwise worthless waste product by a series of steps of chemical construction in which no forces are involved but those of the chemical affinity between such substances as the ordinary acids, alkalies and salts.

While, therefore, it is a fit substance for madder and its preparations, because with it we can accomplish essentially all the valuable results obtained from madder and its preparations as dyestuffs, we can, by its agency, accomplish these results better, and, to a certain extent, by the agency of new instrumentalities.

(Notice is given that at the hearing herein a motion will be made to strike out the whole of the foregoing answer as incompetent.)

Q. 8. Please state whether or not in your opinion any person skilled in the art or science to which the invention described in complainants' patent Exhibit A relates, would be enabled, by following the description in said patent, to make and use the product described and specified in the claim thereof?

A. There would be no difficulty.

Q. 9. State whether or not you have manufactured the article described and specified in the claim of Exhibit A, by the methods set forth in it, and whether once or more times.

A. I have a great number of times; probably, fifty times, at least.

Q. 10. State whether or not there would be, in your opinion, any difficulty in practically carrying out and applying to the use in the arts, the invention described and specified in the claim of said patent, by the means set forth in it?

A. There would be none, in my opinion.

Q. 11. What has been the result or effect of the invention speci-

fied in complainant's patent, Exhibit A, in connection with the industries of dyeing and calico printing, so far as you know?

(Objected to as incompetent.)

412 A. It has been to largely modify the processes used in that art, causing the employment of the process known technically as topical printing, or the application of the colored pattern to the cloth, by printing on the mordant and dyestuff previously mixed together, to be employed extensively in place of the process of dyeing in which the pattern is printed on the cloth with the mordant alone, and the dye is applied by passing the mordanted cloth through a vat containing the dyestuff in solution.

I have visited one large dye-works where they had practically abandoned their dye vats, and were doing all their work by topical printing with artificial alizarine, though this involved the throwing out of use of a very valuable "plant" or apparatus.

Q. 12. What, if any, acquaintance have you with the arts of dyeing and calico printing?

A. For the last ten or more years I have known Mr. Hunter, of Philadelphia, who has there a very large print works, and was one of the first, if not the very first, to introduce the practical use of artificial alizarine in this country. He was one of the board of managers of the Franklin Institute during most or all the time—some seven years—that I was resident secretary, and he frequently conversed with me in reference to this subject.

When Mr. Alfred Peraff first came to this country, he brought letters of introduction to me, and I frequently saw him also at the time he was making experiments in the use of dyestuffs with Mr. Hunter.

I have visited Mr. Hunter's works and other similar establishments, and have interested myself in the subject, so as to read the literature pertaining to it, and conversed with those engaged in such business.

I have also made, in my own laboratory, numberless experiments with dyestuffs, for my own information, and have been accustomed in lecturing to my classes to exhibit many experiments illustrating the action of various dyestuffs, and the method of their use.

Q. 13. What effect, if you know, has the invention which is made known in complainant's patent, Exhibit A, had upon the use of madder and its different preparations?

(Objected to as incompetent.)

A. It has in England, for example, as appears from statistics which are on record, reduced the importations of madder to a small fraction of what they were before this discovery.

It has, to my own knowledge, caused several dealers in New York city, who formerly imported madder extracts, to discontinue such importation, so that recently, desiring to procure some green alizarine, which was at one time largely bought and sold, I was unable to find any, even in the hands of dealers who had before dealt in it.

413 At the works of Mr. Hunter, to which I have already referred, I saw many tons of madder stored away as practically valueless, and I understood from him that he had, in effect, abandoned the manufacture of madder extract, in which, before, he did a considerable business.

The literature of the subject is full of references to the immense effect which this discovery has had upon all the madder industries.

Q. 14. In your answer 6, you speak of yellowish flocks of isopurpurine which were precipitated in the progress of your test; state whether that body is included among the three bodies which you say in the succeeding sentence are not found in madder root or its preparations?

A. This question draws my attention to an oversight, in that, in recapitulating the result of these tests in the succeeding sentence to which you refer, I have used the word anthrapurpurine where I intended to say isopurpurine.

Adjourned to March 26, 1877.

MARCH 26, 1877, 3 p. m.

Continuation of the direct examination of Prof. MORTON:

Q. 15. What is the origin and history of the word "alizarine?"

A. This word was introduced in the language of chemistry by Robiquet and Colin in 1827, in an article published in the "Annales de Chimie et de Physique," vol. 34, p. 240, in which they describe their discovery of a dyeing principle extracted from madder in the form of yellow-red crystals. Speaking of these crystals they say:

"We propose to name them alizarine, which we take from the word ali-zari, used generally on the Levant, and which is now established in commerce to designate the entire madder root."

Though this substance, isolated by Robiquet and Colin, was never introduced practically as a dyestuff, it was supposed by them, and by many others, to be the essential dyeing principle of madder. This opinion, however, was strongly contested, even at an early period, by other high authorities and investigators, such, for example, as Runge, Wolff, and Strecker, and others. Notwithstanding, the term came to be very frequently used as an equivalent for madder dye generally. Thus, for example, in a work entitled "Das Anthracen und seine Derivate," by G. Auerbach, Berlin, 1873, I find on p. 98 the following expression:

"The alizarine which separates is colored a dark orange brown," the substance to which the author here refers being a very impure mixture, containing many things besides the pure alizarine isolated by Robiquet and Colin."

414 Again, on p. 71 of the same book I find as follows:

"At the first moment it may appear strange that the percentage composition of a body, which is yearly consumed in such enormous quantities, is not yet known with certainty. We can,

however, understand this, when we remember in what a condition alizarine comes into commerce. Even the best preparations, which until a few years ago occurred in commerce, contained only a few per cent. of dyestuff."

Here we have the word alizarine used to designate preparations which the author tells us were used in immense quantities, and contained only a few per cent. of dyestuff.

Again, in the "Journal of the Chemical Society of London," vol. 23, p. 140, in an article by Perkin, I find the following:

"The coloring matter obtained either by Graebe and Liebermann's original process, or from the sulpho-acid of anthrachinone, I have invariably called alizarine."

Again, in the work entitled "A Practical Hand-Book of Dyeing and Calico Printing," by William Crookes, F. R. S., &c., London, 1874, on p. 266, under the heading of "Madder," I find as follows:

"The remaining liquor from which the purpurine has been removed is boiled, when carbonic acid is disengaged and a blackish green pulverulent matter is thrown down, which is alizarine, stained with a very dark green substance, a product of decomposition of chlorogenin. The liquid should be kept at a boil for fully two hours, in order to insure the complete precipitation of all the raw or, so called, green alizarine. The green alizarine is completely thrown down and settles in from 24 to 36 hours. Since it is in a very fine powder, it clings to the sides of the vessel, and only falls to the bottom on agitation. The super-natant liquid is run off, and the alizarine thrown upon a stout canvas filter and thoroughly washed with cold water. When the boiling process has been carried on sufficiently long, the dark, yellow mother liquor does not contain any more utilizable coloring matter. The alizarine is washed until all the acid is thoroughly removed. The crude material thus obtained is a most excellent dyestuff. * * * * * * * * * * Several processes have been proposed to obtain pure alizarine from this, but none are readily practicable on a large scale, owing to the expense of the solvents and from the difficulty of separating the impurities from large quantities of alizarine.

"The following process is the best and quickest: One part of the raw alizarine is boiled with," &c.

We have thus on the same page the word "alizarine," used nine times in immediate succession, and the word is once more used at the foot of the page. Out of all these ten uses, it is only once employed to indicate pure alizarine, as is evident from the passage just quoted.

415 In the same work, on page 246, I find as follows:

"If the mother liquor is now allowed to boil for two hours, the so-

called green or crude alizarine separates out and is deposited in 24 to 30 hours, as a greenish-black mass."

Again, in a work by Schützenberger, entitled "Traité des matiéres colorantes, Paris," 1867, vol. 2, pp. 164, '5, I find as follows:

"The green alizarine, treated with alcohol or wood spirit, dissolves partially, and gives solutions of very strong brownish yellow color. By decanting the clean liquid and evaporating or, better, by distilling it, we attain as a residue a brownish yellow alizarine, tolerably pure."

On p. 165, in speaking of the extract of green alizarine in coal oil, he calls it "coal oil charged with alizarine."

Again, in "Dingler's Polytechnisches Journal," vol. 216, p. 451, I find as follows:

"It is to be noticed that this pinkoffin is more frequently in England, as well as in France, brought into commerce under the name of purpurine. This name designates just the opposite of what the article really represents; it should rather be called alizarine."

Again, in Schützenberger's work above quoted, vol. 2, pp. 151 and 152, we have as follows:

"Alizarine (G. Schaeffer,) commercial or Pinkoffin—Messrs. Pinkoff, Schunk & Co., of Manchester, introduced into the market during 1854 a variety of garancene, known by the name of commercial alizarine. This product presents itself in the shape of a fine powder of a chocolate color."

In fact, I think, from my reading and from conversation with scientific and practical men conversant with this subject, that the word alizarine is constantly used simply in a general sense to indicate a dye-stuff having the general properties of the old and familiar madder extracts; at the same time the word alizarine is also used in a strict chemical sense to indicate a body similar to that isolated by Robiquet and Colin, and which we now believe to have the composition indicated by the formula C_{14}, H_8, O_4.

The context will, I think, always show in which sense the word is used.

Q. 16. How is the word alizarine used in complainants' patent?

A. In a general sense to indicate a dye-stuff capable of
416 being used as a substitute for the well known preparations of madder in dyeing and calico printing, and bearing in mind the previous description contained in their patent to which they apply the name alizarine, they evidently intend to indicate by this word the product of the reactions therein described; that is, a new body artificially produced by a series of chemical steps of construction in which from simpler radicals or roots a more complex body or mixture of bodies is built up by a series of purely artificial chemical steps.

Examination adjourned until further notice.

MONDAY, *March 25th*, 1878.

Present—Counsel as before.

Professor HENRY MORTON's direct examination continued:

Q. 17. If you have since you gave your previous testimony in this case further examined defendant's artificial alizarine taken by you from the bottle Exhibit C, please state the result of such further examination?

A. At the time of my previous deposition I had carried the examination of the material, Complainants' Exhibit C, as far as separating out from it anthrachinone, monoxanthrachinone, and isopurpurine, leaving a baryta lake, which contained whatever alizarine and anthrapurpurine might be present. I have since treated this lake in the following manner: I added a quantity of hydrochloric acid sufficient to convert all the baryta into chloride of barium, which was then removed by washing and filtration from the organic matters, (chiefly alizarine and anthrapurpurine.) Those I then dissolved in a solution of carbonate of soda, and mixed with the solution a sufficient amount of freshly prepared and thoroughly washed hydrate of alumina, to have formed an alumina lake with the entire material, had it been all alizarine. This mixture was digested for some time, filtered, and again treated with additional water and carbonate of soda; the filtrates or solutions running through, which should contain the anthrapurpurine, and which were of a dark purple color, were collected and treated with hydrochloric acid, by which the anthrapurpurine was precipitated as a yellowish floculent material.

The alumina, which retained the alizarine in combination with it after having the anthrapurpurine washed out from it by the carbonate of soda solution, as above stated, was then decomposed by hydrochloric acid, which removed the alumina as a soluble chloride, leaving alizarine as brownish yellow precipitate. This was thoroughly washed and then tested in the usual manner, showing it to be alizarine.

Adjourned to the 27th inst. at 1 p. m.

417 APRIL 3d, 1878, 1 p. m.

Present: Counsel as before.

Prof. Morton present for cross-examination.

Adjourned to April 15, 1878.

NEW YORK, *April* 15, 1878.

Continuation of the examination of Prof. HENRY MORTON.

Present: Counsel as before.

Cross-examination by Mr. Dickerson, of defendant's counsel:

x-q. 18. About how long were you occupied in making the researches which gave you the information upon which you testified in the case of Badische *vs.* Higgins, and afterwards against the Hamilton Manufacturing Company and Cochrane?

A. In going through all the operations involved in separating madder into its constituents, purifying the same, and experimenting with them, and in doing the same thing for the artificial alizarine, I was engaged over a year.

x-q. 19. How many assistants did you employ in the work?

A. One.

x-q. 20. About how much was the cost of making the researches by which you made your discoveries?

A. I do not claim to have discovered in this connection facts not previously developed by other investigators, such as Rosenstiehl, Perkin, Auerbach, and others, but simply to have repeated upon these materials (madder and artificial alizarine) their processes of separation. I should estimate the value of the time and material spent in this work at about $2,000.

x-q. 21. Does not the investigation, from its nature, necessarily require very long time, and very large volumes of solutions, in order to arrive at accurate results?

A. This depends upon the nature of the results at which we desire to arrive. Simply to find out whether a specimen of dye-stuff is produced from madder root, or is artificial alizarine, may be settled to one's own satisfaction within a day, and with a very small amount of material, but to prepare considerable quantities of all the
418 materials of importance in these bodies, so as to make exhibits of swatches dyed with them, and other things required for a full explanation of the whole subject, does require a long time and a considerable amount of material.

x-q. 22. Did you mean to say that you only followed and verified the experiments of Rosenstiehl, Perkin, Auerbach, and others, and produced the results that they produced?

A. I do, with the simple addition that I also made the product in accordance with the description furnished in the patent of Graebe and Liebermann.

x-q. 23. Have you any personal acquaintance with the experiments of Rosenstiehl, Perkin, Auerbach, and others, or did you derive your information of their works from publications?

A. I derived my information altogether from their publications.

x-q. 24. Do you understand that Rosenstiehl, Perkin, and Auerbach have made any particular researches on this subject?

A. I do.

x-q. 25. Are they considered among chemists to be authorities on this question?

A. Each in his own sphere, and within certain limits, they are.

x-q. 26. What do you mean by the limitation of that answer; do you mean that their investigations are imperfect or insufficient?

A. I mean that neither of them has investigated the whole subject, and that in the particular case of Perkin his personal interest as a rival patentee and manufacturer to Graebe and Liebermann obliges us to consider many of his theoretical conclusions with great caution.

x-q. 27. Then you mean that of these three, Perkin's investigations are false?

A. By no means; Perkin's investigations which led him to the separation of anthrapurpurine from artificial alizarine are entirely sound, as I feel convinced from having repeated his processes with the production of the same results which he describes; but he has published some general statements of a theoretical character, which I do not think are well founded, or to be regarded as safe authority.

x-q. 28. What statement of Perkin's bearing on this question do you consider untrue?

A. In a lecture published in the periodical called "*Nature*," on the 14th of September, 1876, Mr. Perkin makes several statements which, I think, bear upon their face the evidence of a strong prejudice, rather than of care and accuracy of statement; thus he says: "The formation of anthrapurpurine in the manufacture of alizarine may, to some extent, be said to have arisen from a want of knowledge of the true conditions required for the production of the latter."

419 This statement certainly looks more like an unamiable reflection upon a successful rival than the development of any scientific truth. Again he says: "The discovery of the artificial formation of alizarine was of great interest, as it was another of those instances which have of late years become so numerous, viz., the formation of a vegetable product artificially; but the process used by Graebe and Liebermann was of little practical value on account of the difficulty and expense of working it." Now, this statement is, at least, a careless one, since it is evident that he here forgets the presence of anthrapurpurine, which he himself had discovered in artificial alizarine and which was not a vegetable product, while his statement that the process of Graebe and Liebermann was of little practical value, is hardly consistent with the fact that they and their representatives have been and are carrying on this process on the largest scale to the present day; these will serve as specimens of the sort of statements of Mr. Perkin, which illustrate, as I think, a strong bias, and cannot be regarded as sound authority.

x-q. 29. I observe also that in your 130th answer in the Higgins case, to which you have now referred in making this answer, you made this statement: "Perkin, however, in omitting all reference to isopurpurine and in speaking of the commercial products as nearly pure alizarine and anthrapurpurine, isspeaking in a manner suitable for a mere popular oral address, but not in a way which adds anything to the accurate statements upon these subjects which I have already given." Is that still your opinion?

A. It is.

x-q. 30. Now assume it to be true that Perkin when he made this statement supposed that Graebe and Liebermann believed that their invention was the invention of a mode of producing practically pure alizarine, would you not say that Perkin spoke justly when he said that the production of anthrapurpurine by that invention "may to

some extent be said to have arisen from a want of knowledge of the true conditions required for the production of" alizarine?

A. I should not so consider it; every discovery involves a previous ignorance of the thing discovered, and, therefore, while it is in a sense true that any discovery involves preliminary ignorance of the thing discovered, to discredit a discovery by describing it as the result of this ignorance does not seem to me a just way of designating it. Assume that Graebe and Liebermann sought simply the artificial production of pure alizarine (C_{14} H_8 O_4); in the course of their efforts to do this they made a new dyestuff, consisting of pure alizarine, anthrapurpurine, isopurpurine, etc. Now to say it was their ignorance of how to make pure alizarine which was the
420 origin of their discovery of how to make the product containing the others, while literally true in words, seems to me an entirely unjust mode of stating the case.

x-q. 31. Do you think that you state Mr. Perkin's language justly or truly when you attribute to him as you do in your last answer the assertion that it was Graebe and Liebermann's ignorance of how to make pure alizarine which was the origin of their discovery of how to make the others, namely, alizarine mingled with anthrapurpurine and isopurpurine?

A. I do not pretend to quote his language, of course, but I believe that I have not departed in the least from the meaning that that language conveys; in other words, I understand Mr. Perkin to state what is an equivalent to this. Had Graebe and Liebermann "the knowledge of the true conditions required for the production of" alizarine, they would not have followed a process for its manufacture which resulted in the production of anthrapurpurine as one of its products.

x-q. 32. Is it not true, to the best of your knowledge, that Graebe and Liebermann did not know the conditions for producing practically pure alizarine from anthracene?

A. It is.

x-q. 33. Is it not also true, to the best of your knowledge, that they believed and claimed that their patented process did produce perfectly pure alizarine?

A. It is not.

x-q. 34. Don't you suppose that they thought that the yellow flocks described in their patent were perfectly pure alizarine?

A. I see no evidence of their having thought so.

x-q. 35. What evidence do you see when they used the word alizarine that they meant something else than pure alizarine so far as the product was a dyestuff?

A. The circumstance that the word alizarine is a generic name for mixed dyestuffs having certain general characters; the fact that when they did speak of pure alizarine they referred to a sublimed extract from these yellow flocks; the fact that as a dyestuff these yellow flocks act very differently from pure alizarine; and the fact that Graebe and Liebermann had made experiments with the yellow

flocks and with the sublimed extract as dyeing materials, makes it to me very probable that at the time when they made their claim for a patent Graebe and Liebermann must have known that their yellow flocks were something different practically from chemically pure alizarine, and that they for that reason claimed it as such yellow flocks simply, had it been their intention to claim simply the chemically pure alizarine C_{14} H_8 O_4.

x-q. 36. In what scientific book published before 1869 was
421 the word "alizarine" used to express anything but the coloring principle in madder?

A. The earliest use of the word alizarine occurs in 1827 in the "Annalls de Chimie et de Physique," where on page 240 of volume 34 we have, in reference to certain sublimed crystals obtained from madder root, the following words:

"We propose to name them alizarine, which we take from the word ali-zari, used generally on the Levant, and which is now established in commerce to designate the entire madder root."

This was the first use of the word, and it here indicates the chemically pure substance, C_{14} H_8 O_5, which is one of the coloring matters or dyeing elements present in madder.

In a work entitled "Traité des Matières Colorantes," Paris, 1867, by Schützenberger, vol. 2, page 164–65, I find as follows:

"The green alizarine heated with alcohol, or wood spirit, dissolves partially, and gives solutions of a very strong brownish yellow color. By decanting the clean liquid and evaporating, or better, by distilling it, we obtain as a residue a brownish yellow alizarine tolerably pure."

And shortly afterwards, on page 165, in speaking of the extract of green alizarine in coal oil, the same author calls it "coal oil charged with alizarine." These two references will suffice to illustrate the two senses in which this word has all along been used: the strict sense of a definite chemical compound extracted from madder, and the general or commercial sense of a mixture of many chemical compounds obtained from the same source and available as a practical dye-stuff. It has in this last sense been used in commerce to designate various extracts of madder root, otherwise discriminated by some additional term, such as green alizarine, yellow alizarine, Kopp's alizarine, or the like, all of which were mixtures of pure alizarine, purpurine, and related bodies.

x-q. 37. Dropping the trade-marks and prefixes to the word "alizarine" which you have introduced into your answer, do you know any technical book before 1869 in which the word alizarine by itself is defined to be a mixture of many chemical compounds, or coloring materials; if so, where is that definition found?

A. I do not know of any such definition of the word, but as it is constantly used, as in the last quotation in my previous answer, or just such a mixture, I have no doubt whatever that that is what it means.

x-q. 38. In your last answer you quote the expression, "we obtain

as a residue a brownish yellow alizarine tolerably pure;" does that author, as you understand him, mean by the words "tolerably pure" that the product was tolerably pure alizarine, or does he mean that it was a tolerably pure compound of a variety of mixtures besides alizarine?

422 A. I believe that the author is here using the word alizarine in the general sense; that is, as describing the available coloring matters obtainable from madder, and that when he speaks of the brownish yellow body as being tolerably pure, he refers to it as a tolerably pure dye-stuff. Such a product is, in fact, as a dyestuff only tolerably pure, and would admit of considerable further purification with an increase of its efficiency.

x-q. 39. Now, suppose in their patent Graebe and Liebermann in place of saying, "we precipitate the alizarine by inorganic acid," had said, "we precipitate perfectly pure alizarine by inorganic acid," what sense would you have given to the words "perfectly pure" there?

A. I should have said that they were conspicuously misapplied, and that this being a misuse of the words, would in nowise define them.

x-q. 40. Do you mean to say that the words would have no sense and convey no idea to your mind?

A. By no means; but I mean to say that I could acquire no knowledge of their meaning from this application of them, but must seek elsewhere for their definition.

x-q. 41. Do you mean to say that those three supposed words, "perfectly pure alizarine," if they had been used in this patent, would not have conveyed the meaning that the product there described was what chemists know as pure alizarine, substantially free from any other ingredients?

A. I have perhaps failed to understand the drift of your last two questions, and will therefore explain what was in my own mind, and what I supposed to be inquired into. I quoted the use of the word "alizarine" by Schützenberger, applied to a body well known not to be pure, as defining the sense in which that word, alizarine, was frequently used, and I understood your reference to the supposed statement by Graebe and Liebermann immediately following as having a similar reference, and therefore stated that if the words "perfectly pure" were applied to a body not perfectly pure, such use would not define or give them a new meaning. I did not, of course, mean to express any doubt as to the well known meaning of the words "perfectly pure alizarine," by which I should, of course, understand the simple chemical substance indicated by the formula $C_{14}H_8O_4$.

x-q. 42. The question I ask is, whether, if the words "perfectly pure" were interpolated in the patent before alizarine, you would understand the patentees to state that the yellow flocks were perfectly pure alizarine in so far as they were a dyestuff, or whether

you would understand him to state that they contained a variety of dyestuffs besides alizarine, which he did not choose to mention?

A. I should, of course, understand him to mean that they were perfectly pure alizarine, such as he knew it to be when pure, that is, the substance indicated by the formula $C_{14} H_8 O_4$.

423 x-q. 43. You stated another reason for thinking that Graebe & Liebermann did not mean perfectly pure alizarine when they took their patent, which was, "the fact that when they did speak of pure alizarine they referred to a sublimed extract from these yellow flocks." Now refer me in the patent to any such statement as that.

A. I have not stated or implied that any such statement is in the patent. What I had reference to was the publication of Graebe & Liebermann in which they first described their discovery and where they say: "We submit to the inspection of the society samples of the sublimed artificial dyestuff as well as patterns of calico dyed therewith."

x-q. 44. From which you infer, do you, that they did not suppose the yellow flocks which they sublimed to be perfectly pure alizarine?

A. Certainly not before they sublimed them, as sublimation is a well-recognized process of separating one material from another, and they would not certainly have placed stress upon the fact of the sublimation had that not been an important step in the preparation of the body about which they were then speaking, viz: chemically pure alizarine.

x-q. 45. Then you mean to say, do you, that what Graebe & Liebermann called sublimed artificial dyestuff could not have been produced from yellow flocks of alizarine, if such yellow flocks had been perfectly pure alizarine?

A. I do not, nor have I asserted anything so foolish; I assume that Graebe & Liebermann were at least men of intelligence, not to say competent chemists, and that when they took the trouble and submitted to the loss of material involved in subliming their product they knew that such sublimation was necessary in order to render that product pure; I also assume that the artificial alizarine in the form of yellow flocks made by Graebe & Liebermann did not differ essentially from the artificial alizarine as yellow flocks made by me when following the directions of their patent; I also assume that Graebe & Liebermann noticed what they saw; observing myself that in subliming artificial alizarine a considerable amount of material is left behind unvolatilized, and that a considerable portion is decomposed and lost, I consider it in the highest degree probable that the care they took to sublime their product, when they wished to bring it before a learned society, as a specimen of pure alizarine, was an evidence that they recognized what any one who had gone through the manipulation must perceive, that the yellow flocks and the sublimed product were very different things.

x-q. 46. Do you really think it would have been a foolish thing

for Graebe & Liebermann to incur this waste of material which you have described, to produce a sample of crystals to exhibit to a society, even though they believed they had pure alizarine in solution, or in yellow flocks, when the crystallized needles of sublimation would add another proof of the identity of their product with alizarine made from madder which was known to exist in needles, resulting from sublimation of that alizarine?

424 A. It would not have been foolish to had prepared a specimen of such, but it would have been foolish to reduce all their material to this condition to have made no mention of the purity of the previous product and to have performed their dyeing tests with these needles so wastefully obtained and moreover peculiarly ill adapted for that use; I may mention that in order to make a successful dyeing test with such needles we must reconvert them into the form of yellow flocks.

x q. 47. Who told you that Graebe & Liebermann dyed their calico with these needles and not with the yellow flocks out of which the needles were made; and do you really believe it to be true, what is insinuated in your last answer, that they did not dye cloth with the yellow flocks of their process and exhibited to the society, but first made sublimed alizarine, and then converted it back again into yellow flocks preparatory to its use as a dye?

A. In the first place, Graebe & Liebermann themselves, in the passage quoted, state as plainly as words can put it, that they dyed the patterns of calico exhibited with the sublimed artificial dyestuff; I moreover know from repeated experiments that the only way in which similar, that is closely similar results on calico, such as they here describe, can be obtained from chemically pure alizarine from madder and from artificial alizarine, is by rendering the latter also chemically pure by sublimation or by other more elaborate treatment, leading to the same result, and not by using the yellow flocks as they are first obtained; the method of purifying alizarine by sublimation is an old one and constantly used, and when the material has been reduced to this needle-like condition it is always by solution and precipitation reduced to the condition of yellow flocks before an attempt is made to dye with it.

x-q. 48. Won't you answer the question, whether you really believe that Graebe did not dye mordanted cloth with what he called his "artificial dyestuff" before it was sublimed, and present the products to that society to prove that he had invented a dyestuff capable of use by a man in the arts and not merely a chemical curiosity existing in the shape of needles, very expensive to produce and perfectly useless, in view of its expense, for the purpose of practical calico dyeing?

A. I will answer this question with a great deal of pleasure, and will merely remark, to begin with, that the only reason why I did not answer before the small portion of it contained in the last question, was that there were so many sections to the same that not having it read over I lost track of this one. I believe that Graebe &

Liebermann did dye cloth with their yellow flocks prior to the time when they took out their patent. Whether they exhibited any cloth so dyed at this particular meeting of the Chemical Society of Berlin, I see here no evidence to prove. That they did exhibit cloth dyed with the sublimed product, I think is stated as clearly as language will convey the fact. The subject of supreme importance in their minds on this occasion was in all probability the having produced artificially a body identical with the chemically pure alizarine existing in madder. When they came to make application for a patent, on the other hand, the question of the applicability, economy, etc., of the product claimed was the important one, and they would desire to secure the entire product of their invention or discovery without limiting themselves by any theoretical considerations.

x q. 49. I observe that this paper was read June 12, 1869, whereas their English patent was applied for in 1868; so that the sequence of cogitation that you have sworn into their brains seem to want the correct chronological element. But I observe, in the quotation referred to, this statement: "Already in our first note we have referred to the fact that we have found no difference between natural and artificial alizarine; that the very characteristic colors produced by both on cotton mordanted with alumina and iron are completely identical." Now, do you mean to say that artificial alizarine and some madder preparation will not dye precisely the same color on mordanted cloth with alumina and iron mordants, so that no man can distinguish between them; or, in other words, can you tell whether a piece of cloth, mordanted with alumina or iron, has been dyed in artificial alizarine, or in some preparation of madder?

A. As this question contains two distinct portions, I will divide my answer correspondingly.

Section 1. As I have sworn or suggested nothing whatever about a sequence of cogitation, I do not see the chronological order of the reading of this paper and the application for the patent has anything to do with the subject. What I asserted was, that when these gentlemen read their paper before the Chemical Society of Berlin, the prominent idea in their minds would be the relation of their discovery to the science of pure chemistry; that when they took out their patent they would have in mind its commercial relations. In mentioning the two in this order, I simply followed the natural logical sequence of the subject.

Section 2. Among the multitudinous varieties of madder extracts and of artificial alizarines, it would no doubt be possible to pick out by trial two that would produce identical shades, but that such a thing should have happened to Graebe and Liebermann on their first attempt is almost infinitely improbable, while nothing would have been more natural than that they should have made both their alizarines chemically pure, when they could of course have obtained identical results with each. If I had the opportunity of applying a very simple test, I do not believe that I should fail to pick out, in

every case, a piece of cloth dyed with madder, and an alumina or iron mordant.

x-q. 50. What is the simple test by which you could ascertain whether two pieces of calico of the same color and shade had been dyed with artificial alizarine, or with madder alizarine?

A. By boiling a fragment in a solution of alum and examining the solution with a spectroscope.

426 x-q. 51. Have you ever applied that test to manufactured calico, and determined which was which?

A. I have, repeatedly.

x-q. 52. Do you suppose that Graebe and Liebermann, when they found the colors to be identical, applied any such test as that to distinguish which was which?

A. I don't think they did, or they would have mentioned it.

x-q. 53. In your accusation against Mr. Perkin's fairness or skill, you quote this from him as a proof:

"The discovery of artificial formation of alizarine was of great interest, as it was another of those instances which have of late years become so numerous, viz.: the formation of a vegetable product artificially."

And you say that this statement is at least a careless one. I observe in Graebe and Liebermann's paper, quoted by you, they say:

"In conclusion, we will refer to the fact that our preparation of alizarine is the first example of the artificial formation of a dyestuff occurring in the vegetable kingdom."

Now in view of that statement by Graebe and Liebermann, don't you think you could withdraw a little of your censure of Perkin for making the same statement?

A. Bearing in mind that my censure is carelessness, and also that Perkin had written very extensive papers about anthrapurpurine, and its great importance as a dye-stuff, and pointed out that while it was a large constituent of artificial alizarine, it was entirely different from anything found in madder, it seems to me that the censure of carelessness is not undeserved, and is in no wise affected by the fact that long before any such developments had been made Graebe and Liebermann, whose attention was evidently concentrated on the alizarine in their product, which *was* found in madder, used essentially the same words in describing it.

x-q. 54. Is not the statement of Perkin, which you have quoted, strictly true in every word of it, viz.: "The discovery of the artificial formation of alizarine was of great interest, as it was another of those instances which have of late years become so numerous, viz., the formation of a vegetable product artificially;" and if it is true, why is he censured by you in this deposition for making it?

A. The context shows that by artificial alizarine Perkin refers to the entire product of Graebe and Liebermann's process, including therefore anthrapurpurine, isopurpurine, monoxanthrachinone, etc.,

none of which are vegetable products; his statement is, therefore, not true.

x-q. 55. Is not coal tar a vegetable product?

A. Not in the sense in which Mr. Perkin must use this word; if coal tar was a vegetable product, so would be anthracene; and there would be no artificial production of a vegetable pro-
427 duct, for all would be vegetable products from the beginning.

Adjourned to Wednesday, April 17th, 1878, at 1 p. m.

NEW YORK, *April* 17, 1878.

Present—Counsel as before.

Cross-examination of Prof. HENRY MORTON continued:

x-q. 56. You also attack Perkin for making this statement, "but the process used by Graebe & Liebermann was of little practical value, on account of the difficulty and expense of working it," and you assert that Graebe & Liebermann "and their representatives have been and are carrying on this process on the largest scale to the present day." Don't you know it to be true that Graebe & Liebermann's process specified in their patent, if practiced as it is there described, is of but little practical value, on account of the difficulty and expense of working it; and don't you also know it to be true that neither they nor their representatives are carrying on that process either on the largest scale or on any scale at the present time? I mean by the process the one described in Graebe & Liebermann's patent, and not described in anybody else's patent.

A. I totally dissent from the statements which you have made throughout. To avoid misunderstanding, however, it will be necessary to define the term process which you have used in a sense that is either ambiguous or incorrect. By process I understand the production of a result by certain specified means or by their unknown equivalents, as, for example, if in a machine something were produced by a process of compression effected by a wedge, I should consider that the process remained the same even if this compression were effected by a toggle-joint, a cam, or any other known mechanical equivalent of a wedge for effecting such pressure. Now, one of the important steps in the process of Graebe & Liebermann was the introduction of two molecules of OH into each molecule of anthrachinone. This they accomplished in the first instance by forming a compound of anthrachinone with two atoms of bromine, and heating this with caustic alkali, whereupon the bromine, combined with the base of the alkali, its place being supplied by OK, furnished from the same source.

On adding any mineral acid to this the K is replaced by H in effect, and we thus obtain the desired result of introducing OH where required. This reaction is well explained in a paper by Wm. Henry Perkin, published in the Journal of the Chemical Society of London, 1870, pages 136–7, where he says:

428 "The reaction may be written thus:

$$\text{“ } C_{14}H_6\begin{cases}(O_2)''\\ Br\\ Br\end{cases}+4KHO=C_{14}H_6\begin{cases}(O_2)''\\ KO\\ KO\end{cases}+2KBr+2H_2O.$$

Dibromanthrachinone. Potassic alizarate.

"The latter product, when treated with hydrochloric acid, yielding hydric alizarate or alizarin.

$$\text{“ } C_{14}H_6\begin{cases}O_2\\ HO\\ HO.\end{cases}=C_{14}H_8O_4.\text{”}$$

Here we see in the $C_{14}H_6$ and in the $(O_2)''$ what we may call the base of the anthrachinone with the two atoms of bromine Br linked to it. The 4 K H O represents four atoms of caustic potash. Of course if caustic soda were used we should simply have Na, the symbol for sodium, in place of K, the symbol for potassium. When these have reacted we have the "base" of the anthrachinone, *i. e.*, the $C_{14}H_6$ and $(O_2)''$ as before, but in place of the two atoms of bromine we have now two molecules of K O, or potassic oxide. The residue of potassic bromide and water, *i. e.*, 2KBr and 2HO, being simply by-products. Lastly, in the final equation we have everything the same, except that H is substituted for K, and the body so produced is alizarine, otherwise expressed by condensing the symbols as $C_{14}H_8O_4$. It is evident that the bromine here acts as a simple carrier, "*loeum tenens*," or middle man, to effect the introduction of the two atoms of OH into the anthrachinone, which in its simple state would be written—

$$C_{14}H_6\begin{cases}(O_2)\\ H\\ H\end{cases}$$

following the method of notation here used by Mr. Perkin.

Now, it was well known at the time of this invention that in many analogous cases sulphuric acid could be used in place of bromine to effect just such replacements, substitutions or introductions as this. Thus in the paper just cited Perkin mentions as an illustration of this very thing the formation of phenol C_6H_5OH, from benzol C_6H_6, by the treatment of the latter with sulphuric acid and the heating of this product with caustic potash.

He also describes the formation of dihydrate of naphthaline:

$$C_{10}H_6\begin{cases}HO\\ HO\end{cases}$$

from napthaline:

$$C_{10}H_6\begin{cases}H\\ H\end{cases}$$

by a precisely identical treatment with sulphuric acid and caustic potash. When, therefore, Graebe and Liebermann themselves first and others after them modified their process to the extent of
429 substituting sulphuric acid for bromine in this step of the reaction, I do not consider that this would be regarded in any sense as another process, but simply as the substitution of one known equivalent for another in their original process. The exact equivalent of one for the other will be well seen if we compare the formula already quoted from Perkin with the following given by him on page 138:

$$\text{“}C_{14}H_6\begin{cases}(O_2)''\\ HSO_3\\ HSO_3\end{cases}+6KHO=C_{14}H_6\begin{cases}(O_2)''\\ KO\\ KO\end{cases}+2K_2SO_3+4H_2O$$

“ Disulphanthraquinonic acid. Potassic alizarate.

The last equation representing the treatment with a mineral acid, being identical in both cases, need not be repeated.

Immediately after the above formula, Perkin says: “The alizarine thrown down from this alkaline product is generally of a bright yellow color, and quite as pure as the analogous precipitate obtained when dibromanthraquinone is employed,” thus giving his testimony to the substantial identity of the products as well as of the processes.

This opinion, which I have so expressed as to the essential identity of the process, whether carried out with bromine or sulphuric acid, is, I believe, abundantly supported by the expressions of other chemists, to be found in the current literature of the subject.

Holding this view, I consider it entirely immaterial whether Graebe & Liebermann or anybody else carry out their original process for the production of artificial alizarine by the use of bromine, or chlorine, or sulphuric acid, or nitric acid, or any other agent, provided such agent was a known equivalent of the first two in the office which it serves in this process.

As to the difficulty and expense of that particular form of the process, if we might call it so, or, perhaps, rather as to the difficulty and expense of the process with bromine as the agent in this step of the same, I should remark that at the present price of bromine it is a serious question with the manufacturers whether that material may not be advantageously employed in this manufacture.

x-q. 57. Won't you answer my question without arguing that the patents of subsequent inventors are really the same thing as Graebe's patent? My question is this: Is it true that Graebe and his representatives, either now or at any other time, manufactured alizarine on the largest scale, or on any commercial scale, by the use of the process described in their patent in this case? and I wish that answered without spending an hour to argue that all possible processes are equivalents of Graebe & Liebermann's process, in which bromine or chlorine were specified.

A. I have made, so far, no allusion to any subsequent invention or inventors, nor do I propose to do so unless such matters are in-

quired into by you. Understanding that, according to my opinion and belief, the invention described and claimed by Graebe and Liebermann in their original patent was the process for producing
430 certain results by the means specified, or by the use of any known equivalents of the same, I reply that it *is* true that Graebe, Lieberman, and their representatives now manufacture, and for a long time have been manufacturing alizarine on the largest scale "by the use of the process described in their patent in this case."

x-q. 58. Without swearing to any conclusions of law, the question of fact is the one I wish answered, viz: Don't you know it to be true that neither Graebe & Liebermann nor their representatives have been manufacturing alizarine on the largest scale, or on any commercial scale, by the use of bromine or chlorine as the same is described in their patent in this case, beginning at the words "we heat anthracene in a vessel of glass or clay," and ending with the words "in the place of bromine chlorine also may be employed, but not so conveniently, as the reactions above described are more difficult to accomplish with chlorine than with bromine." You will save a great deal of time by omitting your testimony as to the legal effects of equivalents, which will not assist the court at all, and also as to what are equivalents, about which you have not been asked a question, and about which, therefore, you are merely a volunteer.

A. Where I consider it necessary for the avoidance of a false statement to define the meaning of the words I use when such definition is rendered necessary by the implications of a question, as well as by its statements, I shall take such time as I consider necessary so to define my words and feel no doubt that the court will support me in so doing. In reply to your question I would say that to the best of my knowledge and belief Graebe & Liebermann and their representatives have been manufacturing alizarine on the commercial scale in accordance with the process described by them in their patent, as referred to by you, with the exception that they have substituted sulphuric acid for bromide or chlorine in that particular step of the process.

x-q. 59. Did you believe when you made your 28th answer, or do you now believe, that when Perkin used the expression for which you condemn him as unfair, viz., "but the process used by Graebe & Liebermann was of little practical value," he meant to say that the sulphuric acid mode of manufacture was of little practical value? On the contrary, didn't you know that he referred to the Graebe & Liebermann bromine and chlorine mode of manufacture when he made that statement? I use the expression "mode of manufacture" to avoid, if possible, another discussion on the legal effect of the word process.

A. Such a change of phraseology is equally unnecessary and useless, if the expressions are intended to be synonymous. What I consider unfair on the part of Perkin is that after having acknowledged the practical identity of those two formal variations of the process

discovered by Graebe & Liebermann, which you may call the bromine process, and the sulphuric acid process, the bromine method of manufacture, and the sulphuric acid method of manufacture,
431 or anything else you please, provided you recognize them to be as they really are, simple modifications in form of the same general process, he, in this place, implies that all which Graebe & Liebermann invented was that special form of the process in which bromine or chlorine was employed, and that they were not the original discoverers and inventors of the whole thing. In other words, he places them, by implication, in about the same position they would have occupied had somebody else made the radical discoveries which are the foundation of their patent, and they had only invented this particular process for carrying it out.

Adjourned to 18th inst., at 11 a. m.

NEW YORK, *April* 18, 1878—11 a. m.

Present: Counsel as before.

Continuation of the examination of Prof. MORTON:

x-q. 60. Won't you answer the question put without indulging in any further attack on Perkin? The question is: Do you not believe that Perkin referred to the bromine and chlorine process when he said that "the process used by Graebe & Liebermann was of little practical value, &c."

A. There being, as I understand it, no such thing as a bromine and chlorine process properly so called, as distinguished from the same process in which sulphuric acid was used in place of bromine or chlorine, I believe that Perkin did not, because he could not, refer to such a process distinctively, except by a misuse of words and false implication, which constitute exactly the unfairness with which I charge him.

x-q. 61. When you were examined in the case of the Hamilton Manufacturing Company, you were asked and answered the following two questions:

"x-q. 3. Do you believe it to be true that there is or ever has been carried on a manufacture of alizarine on a commercial scale, in the manner described in Graebe & Liebermann's patent; if so, where do you believe such manufacture to have been carried on?

"A. I believe that it was so carried on for a short time by Graebe, Liebermann & Caro, at the works of complainants."

"x-q. 54. How many years ago, how short a time, and to what extent?"

"A. This was, as I believe, in 1869, and my impression is that the quantities amounted to some hundreds of pounds."

Now, didn't you mean by those answers that Graebe & Liebermann had used, for a short time, bromine or chlorine for the manufacture of alizarine?

432 A. I did.

x-q. 62. Now, don't you believe that when Mr. Perkin said

that "the process *used* by Graebe & Liebermann was of little practical value," he referred to the same fact that you testified to in those answers quoted?

A. If Mr. Perkin did refer, exclusively, to this form of the process, he then failed to express himself accurately, for by omitting to say the process—using that word in a loose sense—or the modification of their process first used by Graebe & Liebermann, etc., he caused it to be implied, as I have already stated, that the process discovered or invented by Graebe & Liebermann consisted in the use of bromine or chlorine, and was not of a general character.

x-q. 63. Question 62 repeated and the witness is requested to answer as to his belief of what fact Mr. Perkin referred to in his statement when he said that Graebe & Liebermann had "used" a process in manufacturing alizarine.

(Counsel for complainant objects to the question as irrelevant and not a proper one, and also because that it has been already fully answered in answer 62.)

A. What I understand Mr. Perkin to refer to, is the fact that Graebe & Liebermann manufactured artificial alizarine from anthracene for the first time by the use of bromine as an agent in their process. This is the fact referred to; the mode of reference carries with it, however, as a necessary implication, that this process was confined to the use of bromine or chlorine.

x-q. 64. On the 22d of November last you swore as follows:

"The sulphuric acid being much cheaper than bromine or chlorine, I have no doubt that any manufacturer of artificial alizarine would employ it in preference to the other."

Was that true at that time?

A. It was truly my opinion at that time.

x-q. 65. Isn't it also true that when Graebe & Liebermann used bromine in 1868, the result was of but little practical value on account of the expense of working it, and that their product was confined to some hundreds of pounds, after which the manufacture ceased, until processes, or modes of manufacture, or prescriptions were made the subject of subsequent patents, and were then used to produce the practical results?

A. My information on the subject into which you inquire is to a very different effect from what you have stated, and I will therefore give it to you as fully as I can.

Early in April, 1869, Mr. Heinrich Caro, then in the employ of complainants, had frequent consultations with Messrs. Graebe and Liebermann on the subject of their newly invented process, in which the employment of sulphuric acid in place of bromine was freely discussed. At the same time,
433 he was so convinced of the value of the process that, at his advice, arrangements were made by complainants with Messrs. Graebe & Liebermann for the commercial working of this process. This was immediately undertaken on the large scale, with the employment of bromine, and while this was going on, experiments with

sulphuric acid having been made, its superior economy led to the abandonment of the bromine process, or modification of process, which otherwise, without such a rival, I have no doubt would sooner or later have come into extended use. As to the patenting of the sulphuric-acid modification, according to my information, an application for such a patent was filed, with the necessary declarations, by Graebe, Liebermann & Caro, before the British consul in Berlin, on the 15th of June, 1869, and were forwarded the same day to England.

x-q. 66. Then do you mean to say that you have any such knowledge of the fact referred to by Perkin as that you can truly affirm the falsity of his statement when he says that the "difficulty and expense" of working the bromine method, or process, or prescription or mode of manufacture, as the same was "used by Graebe & Liebermann," made it of "but little practical value?"

A. I will give you means of judging for yourself as to the relative weight of the two statements.

Through the neglect of the patent solicitors to whom Graebe, Liebermann & Caro's application was sent it was not presented in proper form until the 25th of June, 1869, and thus an application by Mr. Wm. Henry Perkin filed on the 26th, and covering the same matter, followed it by one day. This led to legal proceedings of some sort, which were finally compromised by some exchange of licenses, which, of course, gave Mr. Perkin an interest in this form of the process as against the original patent. What knowledge Mr. Perkin actually possessed as to the events which transpired at complainants' factory I have no means of judging. What I have myself stated is derived essentially from a series of declarations by Messrs. Caro, Graebe, Liebermann, Perkin, and several others—I think solicitors in London—who were cognizant of the matters in question.

x-q. 67. Did Messrs. Caro, Graebe, Liebermann, or London solicitors, to your knowledge, ever deny the truth of Perkin's statement, that the bromine process, or mode, or prescription, as the same had been used by Graebe & Liebermann, was of but little practical value on account of the difficulty and expense of working it; and if so, which one made that denial; when and in what manner, and to whom did he make it, to your knowledge?

A. As Mr. Perkin's statement which you have quoted was made about six years after the time to which I refer any such explicit denial as you seem to inquire about is, of course, out of the question; in so far as the facts affirmed by Perkin are inconsistent with the facts affirmed in my statement in answer to question 65, this denial
434 or correction is by anticipation made in the declaration of Heinrich Caro, supported by those of Messrs. Graebe & Liebermann, to which I have alluded.

x-q. 68. Haven't you known during this examination that Graebe & Liebermann, in their report at the Vienna Exhibition in 1873, from which you have quoted in some of your examinations on this question, which was made some years before Perkin's statement that their

original patent which described the bromine process was then only a subject of "historical interest?"

A. As a matter of fact, this statement was not in my mind, and before commenting upon it I should like to see precisely what the words of the statement were, as this is a subject in which precision of statement may be very important.

x-q. 69. Did you not also know that when Perkin made that statement Graebe & Liebermann and their representatives were manufacturing alizarine according to a process or mode of manufacture or prescription which was the subject of a patent in which three persons claimed to be joint inventors of the process patented, namely, Graebe, Liebermann & Caro?

A. I did.

x-q. 70. Did you not mean to assert in this examination that the process or mode of manufacture now used for the production of alizarine was simply a well-known equivalent for the bromine process described by Graebe and Liebermann in their original patent—that is, well known at the time of their original patent?

A. I have asserted, and I do believe, that the manufacture of artificial alizarine by the use of sulphuric acid is the same process as the manufacture of artificial alizarine by the use of bromine, involving simply the substitution for the bromine of a substance known to be its equivalent in such reactions at the time of the invention.

x-q. 71. Then, as you have assumed that Graebe & Liebermann were "men of intelligence, not to say competent chemists," if it is true that the process subsequently patented by Graebe, Liebermann & Caro consists only in the substitution of one well-known equivalent for another in the bromine process, then it must be true, must it not, that they knew when they took their patent describing bromine that sulphuric acid was a simple equivalent for it, and could be substituted for it in their patent producing the same result?

A. That is my opinion.

x-q. 72. Have you any other accusations to make against Perkin more serious than those you have made, or against Rosenstiehl, or Auerbach?

A. I have made no accusations against anybody, but have simply pointed out that Mr. Perkin, being in the position of a rival inventor and manufacturer to Messrs. Graebe & Liebermann and the complainants, his theoretical conclusions were likely to
435 be biased by his personal feelings or interests where these were involved, and must in such cases be accepted with reasonable caution. I have nothing beyond this to say about him.

x-q. 73. Have you anything to say about the others named, with respect to their honesty or capacity?

A. Nothing.

x-q. 74. Didn't you have occasion to express an opinion on the substantial identity of artificial alizarine with madder preparations before any litigations arose under this patent?

sulphuric acid having been made, its superior economy led to the abandonment of the bromine process, or modification of process, which otherwise, without such a rival, I have no doubt would sooner or later have come into extended use. As to the patenting of the sulphuric-acid modification, according to my information, an application for such a patent was filed, with the necessary declarations, by Graebe, Liebermann & Caro, before the British consul in Berlin, on the 15th of June, 1869, and were forwarded the same day to England.

x-q. 66. Then do you mean to say that you have any such knowledge of the fact referred to by Perkin as that you can truly affirm the falsity of his statement when he says that the "difficulty and expense" of working the bromine method, or process, or prescription or mode of manufacture, as the same was "used by Graebe & Liebermann," made it of "but little practical value?"

A. I will give you means of judging for yourself as to the relative weight of the two statements.

Through the neglect of the patent solicitors to whom Graebe, Liebermann & Caro's application was sent it was not presented in proper form until the 25th of June, 1869, and thus an application by Mr. Wm. Henry Perkin filed on the 26th, and covering the same matter, followed it by one day. This led to legal proceedings of some sort, which were finally compromised by some exchange of licenses, which, of course, gave Mr. Perkin an interest in this form of the process as against the original patent. What knowledge Mr. Perkin actually possessed as to the events which transpired at complainants' factory I have no means of judging. What I have myself stated is derived essentially from a series of declarations by Messrs. Caro, Graebe, Liebermann, Perkin, and several others—I think solicitors in London—who were cognizant of the matters in question.

x-q. 67. Did Messrs. Caro, Graebe, Liebermann, or London solicitors, to your knowledge, ever deny the truth of Perkin's statement, that the bromine process, or mode, or prescription, as the same had been used by Graebe & Liebermann, was of but little practical value on account of the difficulty and expense of working it; and if so, which one made that denial; when and in what manner, and to whom did he make it, to your knowledge?

A. As Mr. Perkin's statement which you have quoted was made about six years after the time to which I refer any such explicit denial as you seem to inquire about is, of course, out of the question; in so far as the facts affirmed by Perkin are inconsistent with the facts affirmed in my statement in answer to question 65, this denial
434 or correction is by anticipation made in the declaration of Heinrich Caro, supported by those of Messrs. Graebe & Liebermann, to which I have alluded.

x-q. 68. Haven't you known during this examination that Graebe & Liebermann, in their report at the Vienna Exhibition in 1873, from which you have quoted in some of your examinations on this question, which was made some years before Perkin's statement that their

original patent which described the bromine process was then only a subject of "historical interest?"

A. As a matter of fact, this statement was not in my mind, and before commenting upon it I should like to see precisely what the words of the statement were, as this is a subject in which precision of statement may be very important.

x-q. 69. Did you not also know that when Perkin made that statement Graebe & Liebermann and their representatives were manufacturing alizarine according to a process or mode of manufacture or prescription which was the subject of a patent in which three persons claimed to be joint inventors of the process patented, namely, Graebe, Liebermann & Caro?

A. I did.

x-q. 70. Did you not mean to assert in this examination that the process or mode of manufacture now used for the production of alizarine was simply a well-known equivalent for the bromine process described by Graebe and Liebermann in their original patent—that is, well known at the time of their original patent?

A. I have asserted, and I do believe, that the manufacture of artificial alizarine by the use of sulphuric acid is the same process as the manufacture of artificial alizarine by the use of bromine, involving simply the substitution for the bromine of a substance known to be its equivalent in such reactions at the time of the invention.

x-q. 71. Then, as you have assumed that Graebe & Liebermann were "men of intelligence, not to say competent chemists," if it is true that the process subsequently patented by Graebe, Liebermann & Caro consists only in the substitution of one well-known equivalent for another in the bromine process, then it must be true, must it not, that they knew when they took their patent describing bromine that sulphuric acid was a simple equivalent for it, and could be substituted for it in their patent producing the same result?

A. That is my opinion.

x-q. 72. Have you any other accusations to make against Perkin more serious than those you have made, or against Rosenstiehl, or Auerbach?

A. I have made no accusations against anybody, but have simply pointed out that Mr. Perkin, being in the position of a rival inventor and manufacturer to Messrs. Graebe & Liebermann and the complainants, his theoretical conclusions were likely to
435 be biased by his personal feelings or interests where these were involved, and must in such cases be accepted with reasonable caution. I have nothing beyond this to say about him.

x-q. 73. Have you anything to say about the others named, with respect to their honesty or capacity?

A. Nothing.

x-q. 74. Didn't you have occasion to express an opinion on the substantial identity of artificial alizarine with madder preparations before any litigations arose under this patent?

A. None that I can recall.

x-q. 75. Were you never consulted by Pickhardt & Kuttroff, before any litigation arose, upon that subject in respect to a tariff question?

A. Never.

x-q. 76. Isn't it true to the best of your knowledge that the substances called by you anthrapurpurine and isopurpurine were not known to exist until long after the date of Graebe & Liebermann's patent in this case?

A. As such they were not recognized, but as soon as the material was used for dyeing it was perceived that something besides or different from alizarine was there present, so that for some time quite a lively controversy was carried on as to whether Graebe & Liebermann's product was alizarine at all.

x-q. 77. Do you mean by the word "alizarine" a chemically pure alizarine; if not, define the sense in which you use it, in your answer?

A. I use it to indicate, in a general way, all the available dyeing materials found in madder. The following quotation from an article by Koechlin, in the Moniteur Scientifique for 1869 will, I think, very well illustrate what I refer to. On page 915 we read as follows:

"These irrefragable witnesses declare that artificial alizarine is neither alizarine nor purpurine, but a new compound superior, for our purposes, to the derivatives of madder."

x-q. 78. Isn't it perfectly certain that *that* statement is untrue, and that artificial alizarine does contain, as one of its ingredients, the identical alizarine of madder associated with anthrapurpurine, instead of purpurine of madder, which is associated with alizarine in that product?

A. Your statement is true as far as it goes, and yet is not inconsistent with the statement of Mr. Koechlin which does not assert, nor of necessity imply, that artificial alizarine does not contain as one of its elements chemically pure alizarine, identical with that found in madder, but simply that, as a whole, it is a new compound, acting effectively, in a different way from madder; all of which is perfectly consistent with the existence of one common dyeing element in each, all the others being different.

x-q. 79. Now don't you know that the lively controversy you refer to was, as to whether Graebe & Liebermann had produced alizarine at all, they asserting that their product was alizarine, and some others denying? I mean by alizarine $C_{14}H_8$.

436 A. I do *not* know that the controversy assumed the form you state or was carried on between Graebe & Liebermann and others. Thus, one of the strongest advocates for the theory that Graebe & Liebermann's product contained pure alizarine was Wm. Henry Perkin, who, in an article in the Journal of the Chemical Society of London, in 1870, to which I have already referred, says, on page 140, as follows:

"The coloring matter obtained either by Graebe & Liebermann's original process or from the sulpho-acid of anthrachinone I have

invariably called *alizarine*. The identity of this substance with alizarine of madder has, however, been called in question. I have, therefore, made some experiments upon this subject, and carefully examined these two products side by side. For this purpose I have employed both purified, sublimed, and unsublimed artificial alizarine, and for comparison purified sublimed alizarine prepared from madder extract."

The author, in a foot note, then gives his method of purifying the unsublimed artificial alizarine, and in another foot note says:

"When purifying artificial alizarine, by converting it into an alumina lake, I found that upon digestion with carbonate of potash, this lake gave a red-colored solution containing a coloring matter, dyeing mordants very similarly to alizarine, with this difference, that the reds were more scarlet and the purples bluer or more slatey."

We thus see that Perkin fully recognized that it was the presence of pure alizarine, as a part of the product, which was in controversy.

x-q. 80. Do you deny that Graebe & Liebermann at and about the time of their invention asserted that their product was perfectly pure alizarine, and that a discussion arose on that assertion?

A. I certainly have never heard such a thing even suggested before, and if they made any such assertion as to the product of the process described in their patent, that is the yellow flocks, they would have acted in a manner not creditable to their chemical experience and knowledge, unless this product had been entirely different in reference to simplicity of constitution, from most others obtained under like circumstances; in which case this would have been one of the most wonderful things about it, and would have excited universal remark. I will venture here to say, as I think it will throw much light upon this discussion, that in all cases of reaction between complex organic bodies and powerful reagents, in addition to the main product which may be the special subject of our consideration, we always get many by-products of an organic character, which may or may not be of value, according to circumstances, but which are always to be looked for; and any chemist who assumed that the total organic product of such a reaction was a single body, without very strong evidence to that effect, would greatly discredit his own reputation.

437 x-q. 81. On the 18th of December, 1868, Graebe & Liebermann deposited their provisional specification in the English patent office, in which they described their bromine process and in which, after saying that the yellow flocks of alizarine are precipitated, they make this assertion: "The alizarine prepared in this artificial way is perfectly pure and can be employed in all the applications to which the different preparations of madder are used."

Does that assertion of Graebe & Liebermann modify your views as to what was the subject of discussion in those days, or do you think that it was simply not "creditable to their chemical experience and knowledge?"

A. The statement of Graebe & Liebermann in the specification

has no earthly connection with the scientific discussion, which, as I have already demonstrated by my quotation from Perkin, was on the subject there mentioned. As to this particular phrase used by Graebe & Liebermann, I have this to say: The circumstances under which words are used often radically affect their meaning; thus, in speaking of a piece of food I might with perfect propriety say, this is a very simple article of diet and perfectly pure, while if I described the same thing in a paper before a Chemical Society as a simple substance perfectly pure, I should, of course, be talking nonsense. Now, I can perfectly well suppose that when in their application for a patent for a practical dyestuff, Graebe & Liebermann were describing their product, having in mind its complex character and its use, they should say, this alizarine, meaning thereby this compound analogous to the mixed dyestuff which gives its value to madder, prepared in this artificial way, is perfectly pure, *i. e.* contains nothing injurious or useless, and can be employed in all the applications to which the different preparations of madder are used, while at the same time they fully recognized that, as a chemical fact, it was a mixture of chemically pure alizarine with various other dyeing elements.

x-q. 82. Do you really mean to say to-day that in your opinion the words "perfectly pure" in that specification do not mean that the yellow flocks described were perfectly pure alizarine in so far as they were a dyestuff?

A. I do mean to swear to-day that in my opinion those words as there used do not mean chemically pure alizarine but do mean pure alizarine, in the same sense in which the word is used when applied as by Perkin to "the coloring matter obtained either by Graebe & Liebermann's original process or from the sulfoacid of anthrachinone;" in other words, to the entire available dyestuff produced in either case.

x-q. 83. That is, you mean to swear that the words "perfectly pure" used in this patent do not qualify the word "alizarine" at all, and that they simply mean that there is a variety of dyestuffs referred to, of which alizarine is one?

A. I do not mean what you say but I do mean that the words "perfectly pure" qualify the word alizarine to their full extent; meaning that the thing indicated by alizarine is there pure or
438 free from anything else; that that thing alizarine is not the chemically pure or simple substance known by that name in works of pure chemistry, but is the alizarine of the arts, as for example in "Ure's Dictionary of Arts, Manufactures and Mines," 1866, Vol. II, p. 88, speaking of the firm of Koechlin, the calico printers of Muhlhausen, he says: "Their alizarine is not a uniform substance as it ought to be if a proximate principle, for samples of it obtained in different repetitions of the process have produced very variable effects in dyeing." It is this sense of the word alizarine as indicating a mixture of various dyeing elements of well recognized character which is here, as I believe, intended.

x-q. 84. The alizarine of the arts in 1866 was madder alizarine either pure or impure, i. e., containing nothing but the coloring matters whose existence and qualities were known, or containing them with impurities. Is not that so?

A. That is very nearly an accurate statement, the only correction I would suggest being that commercial alizarine contained not only the coloring matters whose existence and qualities were known, but all that were there, whether they were known or not.

x-q. 85. Before Graebe'e patent appeared the words "perfectly pure alizarine" had some meaning, had they not; and if so, state precisely what that was, if you know? If you do not know, say so.

A. These words, like many similar ones, had at least two meanings which could always be discriminated by their location and context. Thus they might mean the simple substance $C_{14} H_8 O_4$, or they might mean a mixture of all the available dyestuff found in madder freed from all other materials.

x-q. 86. Was the formula known before Graebe discovered it in 1868?

A. It was not.

x-q. 87. Then what was known by perfectly pure alizarine before that formula was discovered?

A. The substance which was afterward proved to possess that formula.

x-q. 88. Was anything else than what you have now defined known as perfectly pure alizarine in 1868?

A. Prior to Graebe & Liebermann's use of the word for their product, nothing.

x-q. 89. And yet you think to-day, do you, after having seen the patent in which those words are used to qualify the word "alizarine," that they didn't mean any of the things then known as perfectly pure alizarine, but meant something else?

A. I do; I think they meant their own product which they called alizarine, because it performed the same office as a dyestuff as those preparations of madder which had been before so designated.

x-q. 90. That is, they didn't suppose their product to be identical with perfectly pure alizarine as it was then known, but characterized it by that name simply because it was a somewhat similar dyestuff; do you really believe that?

439 A. Not exactly that, but I do believe that they recognized their product as consisting, to a considerable extent, of that chemically pure or simple alizarine first recognized by Robiquet & Colin, together with other unknown dyeing elements; that on account of this very close relation to the chemically pure alizarine of madder, they called it by that name, and used the word pure in rather a careless way to indicate that it did not contain injurious or worthless material.

x-q. 91. That is, they knew that it contained dyeing elements not existing in madder alizarine, but, because it was pretty nearly the

same thing as madder alizarine, they gave it the name of perfectly pure alizarine; isn't that what you mean to say?

A. Not by any means; I don't think they knew whether the dyeing elements other than chemically pure alizarine, which it contained, did or did not exist in madder. They named it alizarine, I think, because they believed chemically pure alizarine identical with that derived from madder was a large constituent of it. They did not name it perfectly pure alizarine, but named it alizarine, using the words perfectly pure in subsequent description, in a manner which, on the face of it, is evidently loose and general.

x-q. 92. Who discovered anthrapurpurine in artificial alizarine, and when, and who is your authority for the fact?

A. Perkin, in the foot-note which I quoted in my answer 79, in 1870 first notices his separation of a material which was undoubtedly anthrapurpurine. Koechlin, in his article in the "Moniteur Scientifique" for 1869 had already observed the peculiar dyeing properties in artificial alizarine due to this same substance. In 1872 Perkin, in the Journal of the Chemical Society, page 659, gives an analysis of this substance, and in 1873 he published a full account of it in the same journal for that year, page 425, and gave the name anthrapurpurine to it. Perkin, therefore, technically discovered it in 1872.

x-q. 93 What is its formula?

A. C_{14} H_8 O_5.

x-q. 94. Who discovered isopurpurine; when, and give your authority?

A. Auerbach, whose publication is found in the "Moniteur Scientifique" for 1872, page 686, as an abstract by E. Kopp.

x-q. 95. The formula of purpurine found in madder is C_{14} H_8 O_5, is it not?

A. It is.

x-q. 96. Do you know the formula of isopurpurine, or has that not been worked out?

A. It is the same as that of purpurine. Lest any misconception as to the necessary identity of the substances from the identity of formulæ should arise, I will take the liberty of mentioning that we have, among organic bodies, utterly different materials with the same formula; a common and familiar example is furnished in butyric acid, which gives its offensive smell to rancid butter, and acetic ether, characterized by a pleasant, fresh, fruit-like smell; such illustrations might be multiplied without end, but, without taking up time to quote others unless called for, I will merely say that identity of formula alone proves absolutely nothing as to any relation of properties in organic bodies.

440

x-q. 97. Who is your authority for saying that these three coloring matters, which have the same formula, are isomeric and not identical?

A. Perkin, in reference to anthrapurpurine and purpurine; Auerbach, in reference to isopurpurine and the other two; and my own experiments and observations in reference to all of them, as I have

prepared them all, made many tests with them, and find them to be radically different.

Adjourned to Saturday, April 20, 1878, 11 a. m.

NEW YORK, *April* 20, 1878—11 a. m.

Present—Counsel as before.

Cross-examination of Prof. HENRY MORTON continued:

The witness states that since the adjournment he has referred to the report of Graebe & Liebermann on the Vienna Exhibition, mentioned by counsel for defendants in Q. 68, and finds that they there say as follows: Having previously described their method of manufacturing alizarine by the use of bromine and chlorine, they continue: "The above methods, which, in a technical point of view, have at present only an historical interest, have therefore been described without further details," etc. This therefore entirely agrees with the statement made by defendant's counsel in his question, as I understand it. As I have already said, this statement was not in my mind in previous portions of this examination, but I do not see that it would modify the conclusions or opinions which I have previously expressed, and which are founded on the statements and publications made by Graebe, Liebermann and others, at or about the time of their original invention, the state of the art at that time, the same being interpreted by such knowlege of facts and terms in chemistry as I myself possess. Graebe & Liebermann, at the time they prepared this report, were, as I believe, interested in supporting their patent for the sulphuric acid modification of their process as against the original form. Their views and modes of expression would therefore be largely influenced by this condition of affairs, and I do not feel that what they said or thought in 1873 should modify
441 conclusions derived from the evidence we have of what they said and thought in 1869 and 1870.

x-q. 98. What is the title of that report or book of the Vienna Exhibition, by Graebe & Liebermann, and when was it published?

A. I do not know its exact title beyond that it occurs in the official report on the Vienna Exhibition, vol. III., section I. 2, and bears date 1873.

x-q. 99. Have you the book with you?

A. I have not.

x-q. 100. Is that the same document from which you quoted in your testimony in the Hamilton Manufacturing Co. case, page 72?

A. It is.

x-q. 101. Is it really your opinion that when Graebe & Liebermann made that report, and said that "the above methods * * have at present only an historical interest," they were giving an untrue coloring to the facts, for the purpose of enhancing the merit of the sulpho-acid process.

A. I do not think that they were consciously and deliberately stating what they knew to be false, but that the statement itself does

give a false color to the facts as I believe them to have existed, and does have the effect you have named.

x-q. 102. In the same report Graebe & Liebermann make this statement:

"Furthermore, there was much difficulty in transferring the above methods to a large scale. Graebe & Liebermann therefore entered connection with the Baden Anilin and Soda Works, in Ludwigshafen, on the Rhine, the largest works in Germany, even on the continent. Originally the experiments were limited to the purification of the anthracene, and the winning of athrachinone by the second-mentioned bromine method, because this, notwithstanding its difficulties, showed some hopes of success. The latter was dropped as soon as the observation was made that the alizarine could be made more simply by means of anthrachinone sulpho-acids. Graebe & Liebermann had originally attempted to obtain anthrachinone sulpho-acids by acting on anthrachinone with sulphuric acid, but the temperatures they employed were not high enough, being no greater than that generally employed in the preparation of sulpho-acids. They had also been misled by the observation that anthrachinone could be sublimed unchanged from strongly heated sulphuric acid. Therefore they hoped little from sulpho-acids, and gave all their attention to improving the above methods. This mistake was avoided, and the modification of the synthesis of alizarine which forms the basis of the industry of to-day was first found by Heinrich Caro, who was an officer of the Baden Anilin and Soda Works, and he made it his task to give (in combination with Graebe & Liebermann) life to the alizarine industry. Caro first noticed that anthra-
442 chinone, if heated with sulphuric acid to above 200°, would give sulpho-acids, which, on fusing with hydrate of potash, formed alizarine, the same as the bromine compound. Perkin noticed the same fact shortly after, or at about the same time."

Do you think that this is a false statement of the facts, or any less than the whole truth; if so, what evidence have you to refute it?

A. Before answering this question I would desire to state that my attention has not been before drawn to this portion of the report of Graebe & Liebermann, as I have no copy of it, and have only before referred to certain passages which were pointed out to me.

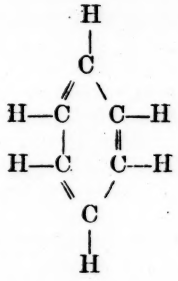
Assuming your quotation to be, as I have no doubt it is, perfectly correct, I should say that the statements therein made, in so far as they conflict with the statements made by Graebe, Liebermann, and Caro at the time of their application for their English patent (to which I have already alluded,) or with the facts expressed or implied in their earlier publications, are untrue or only partially true. The evidence to which I would refer is to be found in the various publications, statements, etc., to which I have already made reference, and in such other quotations as to the state of the art at the time of Graebe & Liebermann's first discovery as may be necessary in further explanation of the same.

x-q. 103. This answer implies distinctly that Graebe, Liebermann

& Caro had made some statements at the time of their application for their English patent or in their earlier publications, which are in conflict with the above-quoted statements made by Graebe & Liebermann in respect to their own acts and deeds at the time when they submitted their report of those acts and deeds to the chemists of the world, who might examine the records of the Vienna Exhibition. Now refer the court to one single word or line ever published by Graebe, Liebermann, or Caro, which conflicts with any part of Graebe & Liebermann's report above quoted. Give the book, patent, or publication which contains the contradiction.

A. You are perfectly correct in supposing that I consider various statements made by Graebe & Liebermann and Caro at an earlier date to conflict with the statement which you have quoted in your question. In order to understand the full force of these statements, however, some explanations as to the meaning of chemical terms, the state of the art at the time, the opinions of other chemists, and facts of chemical science, will need to be referred to.

To put this matter into the clearest form, I will therefore state exactly what I understand to have been the early history of this discovery, quoting from Graebe & Liebermann, and others, such statements as bear upon the subject. Prior to 1869 Graebe & Leibermann had devoted themselves to the study of a very interesting class of compounds known as chinones of the aromatic or benzole series, and had shown that in accordance with the admirable theory of Kekulé, the first of them was a derivative of the base
443 of this aromatic series benzole, in which two atoms of hydrodrogen were replaced by two atoms of oxygen, but with the peculiar condition that these two atoms of oxygen were linked to each other. In other words, following the graphical method suggested by Kekulé, while benzole C_6H_6 would be represented as follows:



where the six carbon atoms are linked together in a closed chain, with the hydrogen atoms attached as indicated, its chinone would be represented as follows:

give a false color to the facts as I believe them to have existed, and does have the effect you have named.

x-q. 102. In the same report Graebe & Liebermann make this statement:

"Furthermore, there was much difficulty in transferring the above methods to a large scale. Graebe & Liebermann therefore entered connection with the Baden Anilin and Soda Works, in Ludwigshafen, on the Rhine, the largest works in Germany, even on the continent. Originally the experiments were limited to the purification of the anthracene, and the winning of athrachinone by the second-mentioned bromine method, because this, notwithstanding its difficulties, showed some hopes of success. The latter was dropped as soon as the observation was made that the alizarine could be made more simply by means of anthrachinone sulpho-acids. Graebe & Liebermann had originally attempted to obtain anthrachinone sulpho-acids by acting on anthrachinone with sulphuric acid, but the temperatures they employed were not high enough, being no greater than that generally employed in the preparation of sulpho-acids. They had also been misled by the observation that anthrachinone could be sublimed unchanged from strongly heated sulphuric acid. Therefore they hoped little from sulpho-acids, and gave all their attention to improving the above methods. This mistake was avoided, and the modification of the synthesis of alizarine which forms the basis of the industry of to-day was first found by Heinrich Caro, who was an officer of the Baden Anilin and Soda Works, and he made it his task to give (in combination with Graebe & Liebermann) life to the alizarine industry. Caro first noticed that anthra-
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Do you think that this is a false statement of the facts, or any less than the whole truth; if so, what evidence have you to refute it?

A. Before answering this question I would desire to state that my attention has not been before drawn to this portion of the report of Graebe & Liebermann, as I have no copy of it, and have only before referred to certain passages which were pointed out to me.

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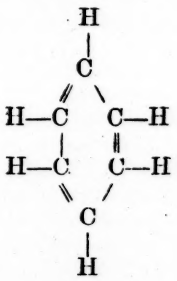
x-q. 103. This answer implies distinctly that Graebe, Liebermann

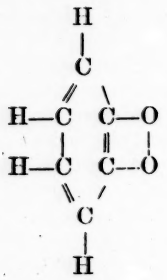
& Caro had made some statements at the time of their application for their English patent or in their earlier publications, which are in conflict with the above-quoted statements made by Graebe & Liebermann in respect to their own acts and deeds at the time when they submitted their report of those acts and deeds to the chemists of the world, who might examine the records of the Vienna Exhibition. Now refer the court to one single word or line ever published by Graebe, Liebermann, or Caro, which conflicts with any part of Graebe & Liebermann's report above quoted. Give the book, patent, or publication which contains the contradiction.

A. You are perfectly correct in supposing that I consider various statements made by Graebe & Liebermann and Caro at an earlier date to conflict with the statement which you have quoted in your question. In order to understand the full force of these statements, however, some explanations as to the meaning of chemical terms, the state of the art at the time, the opinions of other chemists, and facts of chemical science, will need to be referred to.

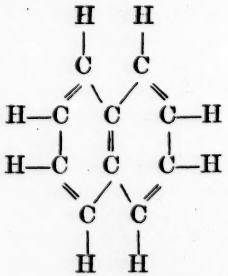
To put this matter into the clearest form, I will therefore state exactly what I understand to have been the early history of this discovery, quoting from Graebe & Liebermann, and others, such statements as bear upon the subject. Prior to 1869 Graebe & Leibermann had devoted themselves to the study of a very interesting class of compounds known as chinones of the aromatic or benzole series, and had shown that in accordance with the admirable theory of Kekulé, the first of them was a derivative of the base
443 of this aromatic series benzole, in which two atoms of hydrodrogen were replaced by two atoms of oxygen, but with the peculiar condition that these two atoms of oxygen were linked to each other. In other words, following the graphical method suggested by Kekulé, while benzole C_6H_6 would be represented as follows:



where the six carbon atoms are linked together in a closed chain, with the hydrogen atoms attached as indicated, its chinone would be represented as follows:



They also found that, starting with naphthaline, the second body in the aromatic series, which would similarly be represented thus:



444 At this juncture the witness states, in reply to a question by Mr. Dickerson, that the answer he is now giving will probably occupy a day, and the counsel for the defendants says that he does not perceive that an essay on alizarine has any possible bearing on the truth or falsity of the statements by Graebe and Liebermann.

1st. That there was difficulty in transferring their bromine method to a large scale.

2d. That the bromine method, notwithstanding the difficulties showed some hopes of success.

3d. That this method "was dropped as soon as the observation was made that alizarine could be made more simply by means of anthrachinone and sulpho acids."

4th. That Graebe and Liebermann had originally attempted to obtain anthrachinone sulpho acids, but had not succeeded, for causes by them mentioned—and then hoped little from sulpho acids, and gave all their attention to improving the bromine and chlorine methods.

5th. That their "mistake was avoided" by Caro, who "first notices that anthrachinone, if heated with sulphuric acid to above 200°, would give sulpho acids," each of which statements is a pure question of fact, not in any degree dependent upon any essay on alizarine; and as the examiner has no control over the witness to re-

quire a direct answer to the question whether Graebe, Liebermann, or Caro have ever denied the truth of any one of these statements in any publication, so far as the witness knows or can produce proof, the counsel for defendant withdraws the question for the present and propounds another, to which he asks a direct answer, without an essay on alizarine.

(Counsel for complainants here gives notice to counsel for defendant that he will move the court at the hearing of this case to strike out the foregoing statements of defendants' counsel from this record, excepting the statement that he withdraws the question, and counsel for complainants states that the witness, when interrupted, was proceeding to answer the question in the only proper way in which a perfect understanding of the matters inquired about could be given, and that complainants' counsel will call for this information at the first opportunity.)

x-q. 104. You have once in this examination shown that, in your opinion, when Graebe and Liebermann, in their English provisional specification, said that the alizarine prepared in the manner specified therein was perfectly pure, they did not mean that it was chemically pure, and in substance that, in your
445 opinion, they would have used the formula of alizarine if they had so intended. I now read to you, from Graebe & Liebermann's Vienna report, as follows:

"The following equations represent the reactions which first give anthrachinone from anthracene, then bibromanthrachinone, and finally alizarine:"

I. $C_{14}H_{10}+3O = C_{14}H_8(O_2)''+H_2O.$
Anthracene. Anthrachinone.

II. $C_{14}H_8(O_2)+4\,Br = C_{14}H_6Br_2(O_2)+2\,BrH.$
Bibromanthrachinone.

III. $C_{14}H_6Br_2(O_2)+2KOH = C_{14}H_6+(OH)_2(O_2)+2KBr.$
Alizarine.

The latter is, of course, contained in the alkaline fusion and is precipitated by acids.

Now, does not this statement in a perfectly accurate and scientific form aver that the product of the bromine process is pure alizarine containing $C_{14}H_8O_4$; answer, if you please, "yes" or "no," without an essay on alizarine?

(Counsel for complainants says that the witness is not restricted to the answer "yes" or "no" suggested by defendant's counsel.)

A. It does not.

x-q. 105. What other coloring material is contained in the 3d formula in which Graebe & Liebermann say alizarine is precipitated by acids? Extract the formula from the equation and exhibit it to the court.

A. There is no other coloring matter than alizarine indicated in the formula to which you refer, which formula simply represents the one thing or dyeing element here specially considered and stated to be contained in the alkaline fusion, and precipitated by the acid; in

describing such a reaction, as I could show by various quotations, one substance alone is followed through its changes, all others being neglected; the absence of reference not involving any assertion that they are not there.

x-q. 106. Then you mean to swear, do you, that if those formulas were presented to you as a chemist you would infer from them that besides chemically pure alizarine some bromine and some potassium, the reaction had produced other materials not specified; and if you so swear, state what the other substances are which the formulas indicate, and state from which of the elements specified in the formulas your supposed substance in addition to alizarine, bromine, and potassium is derived, and how many atoms it has?

A. If I were ignorant of the subject of chemistry I might make the mistake of supposing that such a formula was intended to represent everything concerned in and resulting from the process described; but having a moderate familiarity with chemical literature, and with the actual phenonema of such relations, I should
446 make no such inference as this, but should, on the contrary, conclude that these formulæ represented so much of the reactions and their results as the author had prominently in mind, and that various other bodies were in all probability produced at the same time with the alizarine, and were present in the final product actually obtained. The source of these bodies might be any or all of those used in the first instance. In other words I would know, or any chemist would know, that if he started with a pound of bibromanthrachinone and the numerical relations of the formula called for three-quarters of a pound of chemically pure alizarine as a result, it would be absurd to expect any such yield. And as a matter of fact in all such manufactures fifty, sixty, or eighty per cent. of the theoretical yield, or the like, is all that is ever obtained.

x-q. 107. Do you mean to say to the court that when Graebe published these formulæ as the result of his invention, and called the product of the reaction alizarine, he did not mean that those formulas truly described alizarine, but did mean that the alizarine he was speaking of was a composition of matter of which chemically pure alizarine was only one of the ingredients?

A. I mean to say to the court that whatever Graebe & Liebermann meant to say, the meaning which his words would convey to any one familiar with chemistry was that those formulæ represented so much of the reactions which took place in his process, as he understood or was then prepared to explain or desirous of explaining, and which involved the production of chemically pure alizarine as their result. His calling the product alizarine involves only the meaning that alizarine, chemically pure, was its chief ingredient, and the only one to which he desires to draw attention.

x-q. 108. Isn't it true that those formulæ describe the process which ends in the yellow flocks described in the patent, assuming that the precipitation by acid of the last member of the third equation has been made as they say it should be made, just as the same

result is described in the patent in extended words? I do not ask you whether Graebe & Liebermann were mistaken or not when they wrote those formulæ, but only whether the reactions described in the patent at length are not the same as those expressed in the formulæ?

A. They indicate the reactions described in the patent, but not the process of the patent. In other words, when the bibromanthrachinone is heated with caustic potash a certain reaction among others, indicated by one of these formulæ, goes on, and with it other reactions not described. Everything, however, that goes on is involved in what I understand as this stage or step of the process.

x-q. 109. Isn't it perfectly certain that the thing called alizarine by Graebe & Liebermann in the matter last quoted is the thing precipitated by acid from the substance expressed by these symbols $C_{14} H_6 (O H)_2 (O_2)''+2K$ Br., in the last member of the third equation?

447 A. It is not. This equation only represents a certain part of the result of the potash fusion, viz., that part consisting of chemically pure potassic alizarate, while the portion precipitated by acids contains everything of an organic character there present.

x-q. 110. I haven't asked you what the precipitate contains as you now understand the subject; I only ask whether this statement by Graebe and Liebermann (whether true or false I care not) does not designate the precipitate from the potassic alizarate by the name of alizarine?

A. In your previous question you asked me not about the *word*, but the *thing* called alizarine, and I answered with reference to that question; the word alizarine is used by Graebe and Liebermann to indicate the precipitate obtained by acids from the product which they indicate by the formula $C_{14} H_6 (O H)_2 (O_2)''+2$ K Br. As this is a chemical formula used by chemists, its true meaning cannot be given without an understanding of, and reference to, the force of such expressions when so used by chemists; this I have already fully explained in previous answers.

x-q. 111. Then isn't it true that in this publication they applied the word alizarine to a precipitate supposed by them in their statement to have been made out of bibromanthrachinone, whose formula they give, which was subsequently treated with potash to produce the alizarate of potassium, from which chemically pure alizarine, whose elements they state was supposed to be precipitated?

A. It is not; their statement amounts to this: they applied the word alizarine to a product obtained by a process whose successive steps are indicated by certain formulæ, which, as is usual with chemists in similar cases, is used to express not every part of each reaction, but only that part which is considered of chief importance at the time; therefore, the formula failing to represent all that is involved, the last of them cannot represent all that exists in this final product.

Adjourned to April 22, 1878, at 11 o'clock a. m.

NEW YORK, *April* 22, 1878—11 a. m.

Present—Counsel as before.

Cross-examination of Prof. HENRY MORTON continued:

x-q. 112. You have not yet told the court what other bodies besides perfectly pure alizarine are indicated to a chemist by Graebe's formulas and equations which you have sworn do not indicate pure alizarine alone. Now what are those other bodies? Name them.

A. If, by perfectly pure alizarine you mean chemically pure alizarine, which would be indicated by the formula $C_{14} H_8 O_3$, I should say that the formula here used by Graebe & Liebermann alone did not indicate anything else but chemically pure alizarine;
448 and I have not stated, as your question implies, if the words are so understood, anything which implies the contrary. Formulæ and equations considered alone can indicate nothing but chemically pure substances, since they are, in their very essence, theoretical expressions of the composition of bodies in an ideally pure and perfect state. While this is evidently true of the formulæ themselves, it is equally true that chemists use them to indicate reactions and the results thereof where the chemical substances indicated by the formulæ are only part of the reactions and substances actually involved, and that consequently when after giving such a series of formulæ as those here under consideration, a chemist states that the last of them or any part of it represents the product obtained, no other chemist would understand him as stating that such product was chemically pure, or did not contain notable amounts of other bodies. For example, in Miller's Chemistry, vol. II., 1867, p. 231, under Preparation of Olefiant Gas, after enumerating the materials used, and the process by which the gas is evolved, the author says: "It is accompanied by the vapor of ether, and towards the close of the process by sulphurous acid in large quantities." And continuing further explanation on the next page, he says: "This remarkable decomposition may be thus explained: Alcohol enters into combination with sulphuric acid, and forms a peculiar compound acid; the sulphovinic or ethylsulphuric acid, which is decomposed by a high temperature; the sulphuric acid is liberated in an unchanged condition, whilst the alcohol breaks up into water and olefiant gas; at the same time a portion of the water with which the acid was at first diluted distills off and accompanies the olefiant gas:

"Alcohol. Sulph. acid. Ethylsulphuric acid. Water.
$C_2 H_6 O + H_2 SO_4$ becomes $H C_2 H_5 S O_4 + H_2 O$.
And by heat.
Ethylsulphuric acid. Sulph. acid. Olefiant gas.
$H C_2 H_5 S O_4$ becomes $H_2 S O_4 + C H_4$."

Here we have the definite statement that alcohol and sulphuric acid, besides olefiant gas, yield ether and sulphurous acid, and yet in the formula the final product is represented simply by the formulæ of sulphuric acid and olefiant gas, no indication whatever being

given of the other bodies. Yet this is a work of the highest authority in chemistry, and no chemist would be misled by this use of the formulæ. Again, we have in Schorleirmer's Chemistry of Carbon Compounds, London, 1874, another work of the highest standing, on p. 484, near the foot, a description of the formation of artificial alizarine, in which formulæ, identical in substance with those you have quoted, are used, and after the last, the author says: "On dissolving the product in water, and adding an acid, impure alizarine is obtained as a yellow precipitate."

449 Here we have the product of the same reaction indicated by the same formula (which, of course, literally can only represent a pure body,) distinctly described as impure alizarine; such illustrations of the manner in which chemists use formulæ in connection with their descriptions of reactions might be multiplied indefinitely, as every work on chemistry is full of them.

If by "perfectly pure alizarine" you mean the actual product of the reaction indicated, regarded as a body free from all impurities, useless or injurious to its action as a dye-stuff, then I say that the formulæ and equations do not fully indicate it any more than the formulæ of Miller indicate the product of the reactions he describes, or than those of Schorlemmer indicate fully the product which he describes as impure alizarine.

x-q. 113. Won't you answer the question without an essay on chemistry? It is this: What other bodies besides pure alizarine does Graebe & Liebermann's quoted statement point out to you or any other chemist? Name them.

A. To your present question I can answer at once that it points out no other bodies, but neither does it tell me that none other are there.

x-q. 114. Isn't it certainly true that this statement is substantially this, viz: Wash the precipitate obtained so as to purge the impurities, if any, and the precipitate will then be chemically pure alizarine. If you deny this, then inform the court what other thing a chemist would expect to find if he worked those reactions as described and washed the precipitate.

A. I do not consider your form of statement the substantial equivalent of the one quoted from Graebe & Liebermann; and in answer to your second clause of your question I would say that any competent chemist would expect to find in this precipitate several organic substances other than chemically pure alizarine. Of course until he found them he could not possibly name them, but he would expect them to be related in composition to chemically pure alizarine, and possibly also in properties.

x-q. 115. Would that expectation be founded upon general experience, that chemical reactions designed to produce definite compounds whose production is the object of the process, usually produce at the same time other compounds not sought after, or would that expectation be peculiar to this patented process and to this lawsuit?

A. It would be founded on general experience.

NEW YORK, *April* 22, 1878—11 a. m.

Present—Counsel as before.

Cross-examination of Prof. HENRY MORTON continued:

x-q. 112. You have not yet told the court what other bodies besides perfectly pure alizarine are indicated to a chemist by Graebe's formulas and equations which you have sworn do not indicate pure alizarine alone. Now what are those other bodies? Name them.

A. If, by perfectly pure alizarine you mean chemically pure alizarine, which would be indicated by the formula $C_{14} H_8 O_5$, I should say that the formula here used by Graebe & Liebermann alone did not indicate anything else but chemically pure alizarine;
448 and I have not stated, as your question implies, if the words are so understood, anything which implies the contrary. Formulæ and equations considered alone can indicate nothing but chemically pure substances, since they are, in their very essence, theoretical expressions of the composition of bodies in an ideally pure and perfect state. While this is evidently true of the formulæ themselves, it is equally true that chemists use them to indicate reactions and the results thereof where the chemical substances indicated by the formulæ are only part of the reactions and substances actually involved, and that consequently when after giving such a series of formulæ as those here under consideration, a chemist states that the last of them or any part of it represents the product obtained, no other chemist would understand him as stating that such product was chemically pure, or did not contain notable amounts of other bodies. For example, in Miller's Chemistry, vol. II., 1867, p. 231, under Preparation of Olefiant Gas, after enumerating the materials used, and the process by which the gas is evolved, the author says: "It is accompanied by the vapor of ether, and towards the close of the process by sulphurous acid in large quantities." And continuing further explanation on the next page, he says: "This remarkable decomposition may be thus explained: Alcohol enters into combination with sulphuric acid, and forms a peculiar compound acid; the sulphovinic or ethylsulphuric acid, which is decomposed by a high temperature; the sulphuric acid is liberated in an unchanged condition, whilst the alcohol breaks up into water and olefiant gas; at the same time a portion of the water with which the acid was at first diluted distills off and accompanies the olefiant gas:

"Alcohol. Sulph. acid. Ethylsulphuric acid. Water.
$C_2 H_6 O + H_2 SO_4$ becomes $H C_2 H_5 S O_4 + H_2 O$.
And by heat.
Ethylsulphuric acid. Sulph. acid. Olefiant gas.
$H C_2 H_5 S O_4$ becomes $H_2 S O_4 + C H_4$."

Here we have the definite statement that alcohol and sulphuric acid, besides olefiant gas, yield ether and sulphurous acid, and yet in the formula the final product is represented simply by the formulæ of sulphuric acid and olefiant gas, no indication whatever being

given of the other bodies. Yet this is a work of the highest authority in chemistry, and no chemist would be misled by this use of the formulæ. Again, we have in Schorleirmer's Chemistry of Carbon Compounds, London, 1874, another work of the highest standing, on p. 484, near the foot, a description of the formation of artificial alizarine, in which formulæ, identical in substance with those you have quoted, are used, and after the last, the author says: "On dissolving the product in water, and adding an acid, impure alizarine is obtained as a yellow precipitate."

449 Here we have the product of the same reaction indicated by the same formula (which, of course, literally can only represent a pure body,) distinctly described as impure alizarine; such illustrations of the manner in which chemists use formulæ in connection with their descriptions of reactions might be multiplied indefinitely, as every work on chemistry is full of them.

If by "perfectly pure alizarine" you mean the actual product of the reaction indicated, regarded as a body free from all impurities, useless or injurious to its action as a dye-stuff, then I say that the formulæ and equations do not fully indicate it any more than the formulæ of Miller indicate the product of the reactions he describes, or than those of Schorlemmer indicate fully the product which he describes as impure alizarine.

x-q. 113. Won't you answer the question without an essay on chemistry? It is this: What other bodies besides pure alizarine does Graebe & Liebermann's quoted statement point out to you or any other chemist? Name them.

A. To your present question I can answer at once that it points out no other bodies, but neither does it tell me that none other are there.

x-q. 114. Isn't it certainly true that this statement is substantially this, viz: Wash the precipitate obtained so as to purge the impurities, if any, and the precipitate will then be chemically pure alizarine. If you deny this, then inform the court what other thing a chemist would expect to find if he worked those reactions as described and washed the precipitate.

A. I do not consider your form of statement the substantial equivalent of the one quoted from Graebe & Liebermann; and in answer to your second clause of your question I would say that any competent chemist would expect to find in this precipitate several organic substances other than chemically pure alizarine. Of course until he found them he could not possibly name them, but he would expect them to be related in composition to chemically pure alizarine, and possibly also in properties.

x-q. 115. Would that expectation be founded upon general experience, that chemical reactions designed to produce definite compounds whose production is the object of the process, usually produce at the same time other compounds not sought after, or would that expectation be peculiar to this patented process and to this lawsuit?

A. It would be founded on general experience.

x-q. 116. Does not that general experience present the difficulties in the way of producing pure definite compounds which are sought after by chemical processes?

A. I have already pointed out in a previous answer that the production of pure definite compounds by chemical processes in which organic substances are concerned is almost unknown.

x-q. 117. Then in the light of these last answers, if I understand them, Graebe & Liebermann's statement is to be understood as if they had written this at the end of it, viz: This precipitate is chemically pure alizarine, subject, however, to the contingency known to all chemists, that it may contain other bodies whose composition we do not know, and which we have not recognized or attempted to formulate. Is not this substantially correct?

450

A. No chemist would have used the expression "chemically pure alizarine" if he meant to qualify it as you have done, but the expression used by Graebe & Liebermann would be perfectly consistent with their intention to express such a state of facts as your statement describes.

x-q. 118. In your testimony in the Higgins case you swore as follows: "By such treatment I find in it, 1st, anthrapurpurine, a body first isolated by W. H. Perkin, as stated above, and named by him anthra purpurine; 2d, isopurpurine, a body first isolated by Auerbach, as stated above, and named by him isopurpurine. These, moreover, are present, not as slight traces or insignificant impurities, but in large proportions, varying from 30 to 60 per cent. It is my belief that to their presence the artificial alizarine owes its efficiency as a dye-stuff. By a proper regulation of temperature and the amount of soda or potash, their proportion in the material may be so increased as to render it a scarlet rather than a crimson dye, and this fact adds greatly to the value of artificial alizarine for many purposes." Also, "the patent of the complainants, giving only general directions that the temperature is to be between 180° and 260° Centigrade. I experimented at various temperatures between these two with amounts of alkalis varying from two to three times the weight of the bibromanthrachinone, as directed in the patent, and with the results above described." Now, so far as you understand and have practiced Perkin's and Auerbach's methods of analysis, do you find it true that by increasing the amount of soda or potash you increase the proportion of anthrapurpurine and isopurpurine in the compound produced; and which of the two bodies, anthrapurpurine and isopurpurine, if either, do you find most increased by the increased quantities of soda or potash?

A. The amounts of material which I was able to prepare did not enable me to make a quantitative analysis of the products. All that I found was that when I worked with large quantities of alkali at a high temperature, I obtained a product which, when treated by the method given by Perkin and Auerbach for separating out isopurpurine and anthrapurpurine, gave a larger yield of the materials so separated out from the alizarine; but I could not say which was most

increased, nor approximately even what was the proportion of increase.

x-q. 119. When you had these two bodies, anthrapurpurine and isopurpurine, separated out, did you analyze them yourself to
451 determine their compositions respectively, or did you rely upon the chemical authorities you quoted for that fact?

A. I did not analyze them, but assumed them to be the bodies named, because they were obtained in the manner indicated by their discoverers.

x-q. 120. You quoted, in your 79th answer, Perkin, where he said, "the coloring matter obtained either by Graebe and Liebermann's original process, or from the sulpho-acid of anthrachinone, I have invariably called alizarine." This you quoted to show that when Perkin wrote it, he used the word alizarine to signify what he knew to be alizarine combined with other coloring matters resulting from the processes suggested, did you not?

A. I quoted this in connection with the other matters quoted at the same time to show that Perkin recognized that the matter in controversy among several chemists at that time, was the existence of chemically pure alizarine in the artificial product, and not whether the artificial product in its entirety was chemically pure alizarine. I think, however, that Perkin, like everybody else, used this word both in its strict and in its general sense, the one or the other being indicated by the immediate or more remote context.

x-q. 121 Wasn't it true at and before that time the product now called artificial alizarine was claimed to be chemically pure alizarine so far as it was a dyestuff, and that there was a discussion over the truth of that claim, in which Perkin took some part?

A. I do not so understand it.

x-q. 122. Don't you understand from Perkin's statement which you have quoted and its context, that when he said he had always called the coloring matter of these processes alizarine, that he meant to say it was chemically pure alizarine so far as it was a dyestuff?

A. Certainly not; because he himself shows that he had at the very time extracted another dyestuff different from chemically pure alizarine from the same products.

x-q. 123. On the same page with the matter you quote from Perkin and in direct connection with it after having given certain tests from which he says:

"We are bound to consider artificial and natural alizarine as identical."

Perkin proceeds to make this statement:

"Artificial alizarine has been objected to as a substitute for madder on the ground that pure alizarine will not produce madder colors, other coloring matters being required. Now the only coloring matter in madder, besides alizarine which is not injurious to the beauty of the colors, is purpurine. * * * * Dr. Schunck re-
marks that after a long course of experiments he has been
452 led to the conclusion that the final result of dyeing with mad-

der is simply the combination of alizarine with the various mordants employed, and recommends the extraction of alizarine from madder prints as the easiest method of preparing it in a state of purity on a small scale. I have made some experiments also in this direction, and have found nothing but alizarine on finished madder prints. I could not detect purpurine even with a spectroscope."

Now in view of that con text which you did not quote, do you still swear that at time it was not claimed that artificial alizarine was chemically pure alizarine so far as it was a dyestuff, and that Perkin was not vindicating that view and answering the objection founded upon its assumption by showing that alizarine was the only valuable dyestuff in madder, and therefore that there was no well founded objection to the use of pure alizarine as a dyestuff?

A. At the top of page 143 of the same article from which you have last quoted a passage on page 141 I find as follows: "Artificial alizarine, as supplied to the dyer and printer, is not chemically pure, and usually produces with alumina mordants colors somewhat redder than madder."

Now in view of this context I do not see how it would be possible for any one to swear that at that time it *was* claimed that artificial alizarine was chemically pure alizarine as far as it was a dyestuff, at least so far as Mr. Perkin was concerned. How all Mr. Perkin's statements in this article are to be reconciled with each other is a question requiring some study. The only point which seems to me perfectly clear is that he uses the word alizarine sometimes in its general and at others in its strict sense, as I have before stated.

x-q. 124. When Perkin says: "Artificial alizarine has been objected to as a substitute for madder on the ground that pure alizarine will not produce madder colors, other coloring matters being required," is not that, as you understand the English language, a perfectly clear statement that "artificial alizarine," (meaning the practical dyestuff made from anthracine), "had been objected to" because it was pure alizarene (meaning thereby chemically pure in so far as it was a dyestuff), "which will not produce madder colors" and which needs other coloring matter in it for that purpose? Now answer that, if you please, without an essay on alizarine, and by construing the paragraph quoted as you understand the English language. I do not wish to know whether at some other place Perkin expressed an opinion as to whether artificial alizarene contained other dyestuffs, but only whether he did not assert that other people claimed artificial alizarine to be chemically pure alizarine in so far as it was a dyestuff.

A. Taking this paragraph by itself and interpreting it without any aid from its context or from any knowledge of the facts as expreessed in the contemporaneous literature, it would unquestionably convey the meaning you indicate.

453 x-q. 125. Now substitute for the two technical words used in that paragraph, viz: "artificial alizarine" and "pure alizarine," any other words you may say—from any knowledge you

have—ought to be substituted, in order to give Perkin's true meaning, if you say that meaning is different from what you have admitted in your last answer it appears to be, what word or words would you substitute for "artificial alizarine" and what words for "pure alizarine"?

A. I have not said or implied that by the substitution of any particular word or words this paragraph could be made to agree with the general sense of Mr. Perkin's article in which it occurs, or with his specific statements in other parts of the same; what I say is, that when a paragraph such as this, taken by itself, is in opposition to definite statements of facts and conclusions in the same article, it cannot be accepted as expressing the opinion of its author; this is the use which you have made of it in previous questions, to which I have objected in previous answers.

x-q. 126. Do you mean to assert that in any part of that article there is a word said by Perkin in contradiction of the statement in the paragraph "that artificial alizarine has been objected to as a substitute for madder, on the ground that pure alizarine will not produce madder colors, other coloring matters being required;" if so, quote the language which contradicts that statement, that the court may judge of the correctness of your conclusions from it, and I quote this language with the meaning which you consented to in your 124th answer?

A. I do not mean to assert that Perkin in any other part of this article denies that somebody had asserted that "artificial alizarine" was nothing but chemically pure alizarine, but I do mean that other parts of his article conclusively show that he did not himself accept this as the true point in controversy; if I have failed to make this clear in some recent answers, it has been because I have been trying to answer to what I considered the true point at issue as stated in the latter part of question 123.

x-q. 127. When you qualified yourself as a witness in the Hamilton Manufacturing Co.'s case to instruct the court as to the facts of Graebe & Liebermann's invention, and when you cited Graebe & Liebermann's Vienna report, on the 72d page of that record, to sustain your assertions as to their invention, did you take the trouble to read that report which purports to be the historical statement by themselves of the facts in the case, or did you only read that paragraph which you quoted and used to support your theory, which the court adopted in its decision?

A. I did not read the entire report, but not being myself familiar with German—in which language the report was printed—had my assistant translate for me that passage to which reference has been made by a mark on the margin of a copy sent to me for the purpose.

454 x-q. 128. Sent by whom, and marked by whom?

A. By Mr. Wm. Pickhardt, I presume.

x-q. 129. Then when you were about to testify as to the facts outside of the patent, you had in your possession Graebe & Liebermann's

own statement of those facts given to the world at the Vienna Exhibition, and did not read it but quoted from other people's statements, in respect to those which were published in other books; is not that so?

A. As so stated, the circumstances of the case are grossly misrepresented; I had read certified statements by Graebe & Liebermann, made close upon the time of their original invention, describing the same when the matter was fresh in their memory, which I had read with care, and whose statements I had verified by experiment; while it is true that a certain German pamphlet containing other statements of theirs was for a time physically in my possession, yet having no knowledge that it contained anything bearing on the subject, except what had been indicated to me; the fact that I did not read it did not involve any such intentional neglect as your mode of stating the matter necessarily implies.

x-q. 130. What do you mean by certified statements by Graebe & Liebermann? Certified by whom and in what form?

A. Certified copies of declarations filed by them in the English patent office or English courts—said copies being certified by some English officials and by the U. S. consul in London.

x-q. 131. Did you produce any of those certified statements, whatever they were, and were they put into the case in any form, or quoted in your testimony as an authority for any statement you made; if so, refer me to the records where they were so produced or cited?

A. They were not.

x-q. 132. In Graebe & Liebermann's Vienna report, when speaking of what they did with their bromine method, they say:

"Originally the experiments were limited to the purification of the anthracence and the winning of anthrachinone by the second mentioned bromine method, because this, notwithstanding its difficulties, showed some hopes of success. The latter was dropped as soon as the observation was made that the alizarine could be made more simply by means of anthrachinone sulpho-acids."

In your testimony in that case you were asked and answered as follows:

"x-q. 53. Do you believe it to be true that there is or ever has been carried on a manufacture of alizarine on a commercial scale in the manner described in Graebe & Liebermann's patent; if so, where do you believe such manufacture to have been carried on?

"A. I believe that it was so carried on by Graebe, Liebermann and Caro, at the works of complainants.

455 "x-q. 54. How many years ago, how short a time, and to what extent?

"A. This was, as I believe, in 1869, and my impression is that the quantities amounted to some hundreds of pounds."

Now, which of those statements is true? and if you assert that they carried on the manufacture of alizarine on a commercial scale in

1869, and made some hundreds of pounds, from whom did you derive that information, and when?

A. That such a manufacture was carried on on a commercial scale I find asserted in a declaration "In the matter of the petition of Heinrich Caro, Charles Graebe and Charles Liebermann, for letters patent No. 1936, 1869.

"And the opposition of William Henry Perkin thereto," where Heinrich Caro states as follows: "I returned to Manheim immediately afterwards, and Mr. Graebe shortly after. In the month of May, 1869, came to Manheim, and we then proceeded to carry out the said invention. We first used the original process, as described in the said specification of the patent No. 3850, 1868; and afterwards we carried out the same process, substituting sulphuric acid for the bromine originally employed."

As to the amount manufactured, my informant was Mr. William Pickhardt.

x-q. 133. Where do you find in this statement that they carried out the bromine process on a commercial scale, or that they ever manufactured a pound of it otherwise than for experiment?

A. I consider that the passage which I have quoted, taken in connection with the statement made in a previous part of the same document, that the arrangement with Messrs. Graebe & Liebermann, made by this company, was for the commercial working of the invention, implies that this was a manufacture on a commercial scale. As to how much was sold, I, of course, know nothing.

x-q. 134. In this document, Charles Graebe makes a statement, and says:

"When the said Charles Liebermann and I were pursuing our researches, we found great difficulty in procuring the material anthracene. It was no article of commerce; we had to procure it from England in small quantities, and were therefore obliged to economize it as much as possible. This occasioned great delay in completing the practical application of the invention. We never carried out the matter commercially until applied to by Mr. Heinrich Caro, in the month of April, 1869, although we had previously
456 had many applications from chemical manufacturers, dyers, and printers, from France, Germany, and the United Kingdom.

* * * * * * * *

"In the month of April, 1869, I was applied to by Dr. Hugo Müller, of London, to send a specimen of artificial alizarine for the use of Mr. Henry Perkin, of London. I replied to that application that owing to the laboratory being closed, it then being vacation time, I had not at that moment any of the artificial alizarine, but that I had a short time previously sent a specimen to Mr. Potter, a large calico printer of Manchester, from whom he could obtain what he required."

Now, in view of that statement, and of Graebe and Liebermann's Vienna statement above quoted, do you still believe it to be true from any evidence you have that Graebe & Liebermann carried out

the manufacture of alizarine on a commercial scale by the bromine process?

A. I do.

x-q. 135. Have you any other evidence of the truth of your statement, except what you have already said; if so, produce it now?

A. Nothing beyond the rest of the document from which I have quoted, that I now remember.

x-q. 136. Is there a word in that document about the commercial manufacture in 1869 except what has been already quoted?

A. I think that there are some statements which more or less directly bear on this point which I will present at our next meeting.

x-q. 137. Do you believe it to be true that the alizarine of the defendants which you examined in this case was manufactured by the bromine or chlorine process?

A. I do not; but by some modification of the same process.

Adjourned to 27th April, 1878, at 11 a. m.

457 NEW YORK, *April* 27, 1878.

Present: Counsel as before.

Cross-examination of Prof. HENRY MORTON continued:

The witness states that since the previous examination he has carefully read over the declarations of Caro and others, to which he made reference in his previous deposition, and does not find therein anything further which he considers it necessary to quote in support of his opinion that Graebe and Liebermann carried on the manufacture of alizarine on a commercial scale at the works of complainants, in 1869, but believes that said opinion is fully sustained by the statement therein, that when Mr. Graebe, in May, 1869, came to Mannheim, they proceeded to carry out their invention, using, in the first place, the process with bromine, and afterwards "the same process, substituting sulphuric acid for the bromine originally employed."

I take this, of course, in connection with the previous statement that the arrangement in pursuance of which this work at Mannheim was undertaken was for "the working of the said invention," or "carrying the said invention into practice."

Since the last examination I have, however, seen a manuscript letter, written and signed by Mr. Liebermann, which was identified, in my presence, by a gentleman familiar with his handwriting, and which, I am informed, will be put in evidence in this suit. This letter is addressed to the Badische Anilin and Soda Fabrik, and opens with a statement to this effect: no one knows better than you that we carried out our original process on an industrial scale. I am not quoting literally, but giving the substance as I recollect it. This letter was dated, I think, in 1875.

(Counsel for defendant now calls upon counsel for complainant to strike out from the record that part of the last answer commenc-

ing with the words, "since the last examination," as an obviously unfair attempt to effect the judgment of the court by what cannot be evidence under any possible circumstances, even if the supposed letter were present, and the supposed person familiar with the hand writing were also present, subject to an examination. The witness has been testifying that certain declarations made by Graebe and Liebermann in 1869 contradicted their Vienna report, and justified his testimony, given about a year ago, and for that purpose produced the certified copy. It is obvious, therefore, that if Graebe and Liebermann should write letters in 1875, or at any other time since the Vienna report was made, that they could have no possible bearing on the question at issue.

458 Counsel for complainant refuses to strike out any part of the last answer, and he reminds defendant's counsel of his questions Nos. 133 to 137, wherein he asks for the very information that the witness has here given.

Counsel for defendant will move to suppress this part of the answer.)

x-q. 138. When did you first see this supposed letter?

A. Since the last adjournment, to the best of my present recollection; I was shown, nearly two years ago, several similar letters from Mr. Liebermann, but did not recolleet this one particularly until I saw it last Wednesday.

x-q. 139. Now, suppose Graebe and Liebermann had said, after giving the equations and formulas quoted in the 104th question, "The alizarine thus artificially prepared is perfectly pure." Would that statement, if there made, modify your views heretofore expressed as to what was intended by those equations and formulas; if so, how?

A. It would depend upon the circumstances. If they were speaking as chemists before a society, or in a chemical journal, I should understand that they meant to indicate that this was one of those rare cases where a reaction was almost exactly in accordance with the theoretical expression of the formula. If, however, they were addressing manufacturers and printers, the words "perfectly pure" would indicate no more than that the article so described was a perfectly pure dye-stuff, free from any of the corrosive chemicals used in its manufacture which might alarm the possible users.

That Graebe and Liebermann did not regard the use of that formula as implying that the product so indicated was chemically pure, appears very clearly from the following: In the *Ann. der Chem. und Phar.*, supplementary volume 7, published in 1870, they give a full account of their researches in connection not only with alizarine, but with the many other bodies they studied prior to this time. Here, on page 289, in connection with the description of the same reactions to which you have referred, they give this same formula with the names written below, as I now copy it:

$$\underset{\text{Bibromanthrachinone.}}{C_{14}H_6Br_2(O_2)''} + 4(KHO) = \underset{\text{Alizarine.}}{C_{14}H_6(OH)_2(O_2)''} + 2\,K\,Br.$$

Then, in continuation of the same general subject, on page 301, speaking of the fusion of bibromanthrachinone with potash, they say: "When the coloration no longer gains in intensity, and a sample taken out dissolves with a violet color, water is poured into the fused mass, the dark violet solution is filtered, and then precipitated by an acid. The alizarine separates in flocks, which are frequently
459 like yellow, but sometimes appear dark-brown. After being washed, it is purified either by crystallization from alcohol, or better by sublimation."

x-q. 140. You have heretofore sworn in substance that the statement of equations and formula given by Graebe and Liebermann in their Vienna report does not signify to you, as a chemist, that the product there symbolized and called alizarine is chemically pure, so far as it is a dyestuff. You now swear that if they had added, to their statement containing those formulas, the words, "The alizarine thus prepared is perfectly pure," it would depend upon the character of their audience what would be meant by those words, and that if spoken to "manufacturers and printers" it would only signify that there were no corrosive substances in the dyestuff "which might alarm the possible users." Now, will you inform the court what would be the appropriate words to be used in order to convey the meaning that as a dyestuff it was "chemicallly pure alizarine," after the author had said:—1. The formula of this substance is $C_{14} H_8 O_4$, which I call alizarine. 2. The alizarine thus prepared is perfectly pure?

A. To take a form of expression already set down, and by additional words give it a required meaning, is of course a different thing from expressing the said meaning originally, but I think if to the words you have given were added the following, viz., in the strict chemical sense containing nothing but what is expressed by the above formula, the meaning you call for will be conveyed.

x-q. 141. Then, in your opinion, whenever you see a set of reactions stated in chemical symbols, resulting in a definite compound, whose name is known and given (as, for instance, sodium chloride,) accompanied by the statement that the sodium chloride is "perfectly pure," you would require the words—(1) "In a strict chemical sense;" and (2) "Containing nothing but what is expressed by the above formula," to be added to the words "perfectly pure," before you would understand the statement to signify that the substance expressed by the formula contained nothing but the elements therein stated?

A. By no means; nor have I asserted anything of the sort in the general way you put it; in the first place I have often and, I think, clearly pointed out that it is only where the reactions of complex organic bodies are concerned that the uncertainty exists as to how far the formula expresses the whole reaction and product; and in the second place, that the context and circumstances must be taken into account in this as in all other interpretations of language.

x-q. 142. Are not the three terms—(1) "Perfectly pure;" (2) "Chemically pure;" (3) "Containing nothing but what is expressed

by the formula"—when predicated of a substance expressed by a chemical formula (as, for instance, C_{14} H_8 O_4) simply synony-
460 mous; and wouldn't you think it an absurd tautology if an author should use all these three terms in addition to the formula, in order to convey the simple meaning that the formula was true and stated all the ingredients that were claimed to exist in the product so symbolized?

A. By no means; the term "perfectly pure" is an expression used in ordinary language with a very general and indefinite meaning, as every one knows; so that while it might be applied to a substance which was chemically pure, it could also be applied, with perfect propriety, to a material which was by no means chemically pure, nor intended to be so described, but about which it was simply intended to say that it contained nothing harmful, injurious or useless, in relation to the uses to which it was to be applied. The expression "chemically pure," and the expression "containing nothing but what is expressed by the formula," are synonymous, and I should consider it a useless tautology if an author used these two expressions, except for the sake of emphasis or explanation to those unfamiliar with the meaning of the term "chemically pure."

x-q. 143. The question I wished answered is this: If one should write chemical formulas expressing reactions, ending with the formula C_{14} H_8 O_4, and should then add these words: "This is alizarine, and it is perfectly pure;" do you mean to assert that such a statement would not be synonymous with the statement—this is alizarine "containing nothing but what is expressed by the formula?"

A. That would depend upon the context and circumstances under which the expressions were used. If these were such as to make it appear that the writer intended by the first expression what the second one is strictly limited to express, then they would be synonymous; but otherwise the first expression is not limited as is the second.

x-q. 144. The only circumstances involved in the question are these: "A writer says: I have executed the following reactions," and he gives you—"1st, the formula of anthracene, then the formula of anthrachinone, as the result of his first step; then the formula of bibromanthrachinone, as the result of the next step; then the formula of the alizarate of potassium, as the next step; then the formula of alizarine C_{14} H_8 O_4, as the final product." And then says: "The alizarine thus produced is perfectly pure." Now, if you assert that this statement means that the final formula, C_{14} H_8 O_4, means anything but chemically pure alizarine, point out in the statement any fact which indicates that meaning, or suggests to the reader that as a dyestuff this substance is something else besides chemically pure alizarine?

A. I have never asserted, nor do I now assert, that the formula means anything more than chemically pure alizarine; on the contrary, it means something less in a quantitative sense; that is, it

means the ideal substance alizarine in a state of absolute
461 purity, such as has never been obtained in fact; in other words it is a mathematical expression for one molecule composed of so many atoms of each element absolutely free from anything else. If, however, by your question you intend to ask whether under the conditions mentioned the product indicated by that formula in the way that chemists are accustomed to indicate such products by such formulæ, I reply that that statement while to a person unacquainted with chemistry it might imply what you suppose, does not convey that meaning to me simply using my general knowledge of organic chemistry and chemical literature to aid me in appreciating the force and meanings of the expressions employed.

x-q. 145. Twelve days ago you swore as follows: "Graebe and Liebermann must have known that their yellow flocks were something different practically from chemical pure alizarine, and that they, for that reason, claimed it as such yellow flocks simply, without giving it a formula, which they could easily have done had it been their intention to claim simply the chemically pure alizarine $C_{14}H_8O_4$.

Now, state to the court what the formula was which you had in your mind and which, if it had been put into the patent, would have converted it into a patent for chemical pure alizarine?

A. I did not say nor imply that any formula put into the patent anyhow would have conferred upon it this meaning; what I stated was that had it been their intention to claim chemically pure alizarine $C_{14}H_8O_4$ they could by the use of that formula, of course in a sensible and judicious way, have so limited their claim; thus had they said, "by these means we receive the alizarine in a form so pure that it consists of nothing but what is expressed by the formula $C_{14}H_8O_4$," they would, I think, have so limited their patent, and this is substantially what I had in mind in my previous answer.

x-q. 146. Then your previous answer was not an argument to prove by the absence of the formula of alizarine from the patent, that Graebe and Liebermann knew they had invented a composition of matter of some kind and not merely a process for making alizarine identical with madder alizarine?

A. It was not so restricted as that; it was an argument to the effect that Graebe and Liebermann, by stopping in their description with the production of their yellow flocks when they might easily have gone further and by the judicious use of a formula in this place have indicated with precision that the yellow flocks here described were chemically pure alizarine indicated, in my opinion, a consciousness on their part that their product contained something else which it would be desirable to secure.

The fact that they used some formula in their provisional application which they withdrew from the patent, confirms this impression,
as it seems to indicate that their attention was then drawn
462 to the misunderstanding which these formulæ might occasion among those not familiar with the way in which these are used among chemists.

x-q. 147. In their provisional specification the formulæ are the same as in their Vienna report so far as they go; and when they are not so full, the description supplies to any chemist the means of writing in all the factors in the Vienna equations. Is not this so?

A. The formula given in the provisional specification only goes as far as indicating the composition of anthrachinone and bibromanthrachinone; this was a new body first prepared by Graebe and Liebermann about this time; the main features of the steps and reactions subsequently described could of course be indicated by any chemist in formulæ with this description before him.

x-q. 148. And isn't it also true that any competent chemist, following the specification of the completed English patent, could put into symbolical equations each of the reactions therein described?

A. He could, bearing in mind that neither the description nor the equations would claim to represent all that went on in or was produced by said reactions.

x-q. 149. And isn't it also true that the Vienna statement and equations are simply a more technical mode of expressing the facts that are stated in the English and American specifications of Graebe and Liebermann's patents, in more popular language?

A. With the limitation that both expressions are partial, as I have explained, they are.

x-q. 150. You mean by "partial," that they do not truly state the facts?

A. I do, in the sense that they only explain so much of the reactions as the writers believed they fully understood and therefore felt themselves competent to explain.

x-q. 151. That is the reactions that resulted in chemically pure alizarine $C_{14}H_8O_4$; is not that so?

A. It is.

x-q. 152. You have said that the sulpho-acid process was a well-known equivalent at the time of Graebe and Liebermann's original patent for the bromine process. You mean by that, I suppose, "well-known" for the purpose of replacing hydrogen by hydroxyl?

A. I do.

x-q. 153. At the time when Graebe and Liebermann executed their process, two atoms of hydrogen had been taken out of anthracene and two atoms of oxygen substituted for them, making anthrachinone $C_{14}H_8O_2$; is not that so?

A. It is.

x-q. 154. At that time it was obvious by inspecting the for-
463 mulas of anthrachinone and of alizarine $C_{14}H_8O_4$, that by adding two more atoms of oxygen to anthrachinone by means of well-known substitution processes, alizarine would result; is not that so?

A. Not by any means.

Adjourned to Thursday, May 2, 1878, 11 a. m.

NEW YORK, *May* 2, 1878—11 a. m.

Present—Counsel as before.

Cross-examination of Prof. MORTON continued:

x-q. 155. So far as you know has Prof. Josiah P. Cooke, of Harvard University, any interest in the question at issue here, such as that which you suppose Perkin and Graebe and Liebermann to have, in consequence of which his published statements of facts or opinions ought to be received with qualifications?

A. He has not; I should however, remark that Prof. Cooke has no personal knowledge of these matters, nor appears to have made any investigations therein, but simply speaks on the authority of such publications as he has examined; the value of his statements would then simply rest on the value or authority of such publications.

x-q. 156. Do you mean that he has no personal knowledge of the chemical principles involved in the reactions for producing alizarine, or that he has no personal knowledge of what Graebe and Liebermann did?

A. I mean that I believe he never made any artificial alizarine himself, or examined any in reference to its proximate composition, and also that he has no personal knowledge of what Graebe and Liebermann did. As to general principles in chemistry I should regard him as very well informed.

x-q. 157. In his Chemical Philosophy, page 563, Prof. Cooke makes this statement: "The substance" (meaning anthrachinone) "had been re-examined by Anderson, who gave it the symbol $C_{14}H_8O_2$, and in it Graebe and Liebermann at once recognized the required quinone; it only now remained to replace two atoms of the hydrogen in this body by hydroxyl, in order to settle the question whether alizarine is the quinone acid of anthracene or not. The method was obvious. Anthrachinone was heated with bromine, which, replacing two of its hydrogen atoms, yielded the compound $C_{14}H_6Br_2(O_2)$,
464 and this heated to 180° with a solution of potassic hydrate, gave an intense blue solution, from which hydrochloric acid precipitated a yellow crystalline powder, identical in every respect with the alizarine obtained from madder."

Now, does not the last statement mean that the yellow flocks precipitated are indentical with alizarine discovered by Robiquet and Colin, now known by the formula $C_{14}H_8O_4$? I do not ask you whether the statement is true or not, but whether that is its meaning, as you understand the text?

A. Bearing in mind that this book is intended as a text-book for students of theoretical chemistry, I have no doubt that Prof. Cooke used the word "alizarine" in its strict sense, and therefore this passage conveys the meaning you state; I have also no doubt that such was Prof. Cooke's meaning when he wrote it; the whole article shows that Prof. Cooke had given no careful study even to the literature of this subject (his scientific work being essentiallly confined to min-

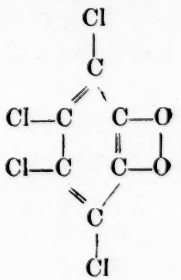
eralogy and its related departments of chemistry and physics); no one would expect him to be well informed as to the details of a recondite subject in organic chemistry, such as this.

x-q. 158. You think it was his want of accurate chemical knowledge which led him to the remark in the quoted passage, that Graebe and Liebermann's "method was obvious"?

A. I do not; I regard that statement as true, provided it is not allowed to carry the implication that while it was an obvious thing that bromine would be a fit agent to use for such a reaction, it therefore followed that it must be successful in producing the desired result. Thus, for example, it could not be asserted beforehand that bromine could be made to replace just two atoms of hydrogen; if it had replaced four, and the subsequent substitutions by potash and hydroxyl had taken place with them, the resulting substance would have been rufegalic acid in place of alizarine, or it might have happened that the replacement of hydrogen by bromine would have caused a breaking up of the anthrachinone molecule; thus, while the method suggested was an obvious one, in the sense of being worthy of trial, it was not obvious that such trial would result in success. It is the use of this phrase in such a way as implies that he did not recognize this distinction that, among other things, leads me to conclude that Prof. Cooke when writing this article was not well informed as to the facts and details involved in this subject.

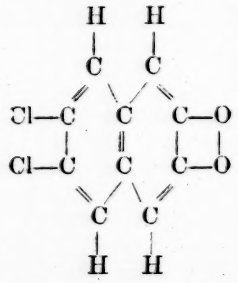
x-q. 159. Were not similar substitutions well known in chemistry in 1868, in producing products in which various oxydizing agents had been employed, and, among others, bromine?

A. Similar substitutions with other bodies, by the aid of bromine or chlorine, were well known; thus, if phenol is heated with potassic chlorate and hydrochloric acid, it will form perchloroquinone;
465 the formula of this substance represented graphically is this:



By heating this with caustic potash two of the chlorine atoms are replaced by OK.

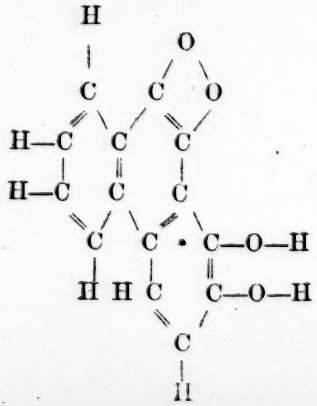
Again, we have a similar action with a derivative of naphthaline, bichloronaphthaquinone. This written in accordance with the same system, would be represented thus:



When this is heated with caustic potash one atom only of the chlorine is replaced by OK. I have here cited instances in which chlorine is the replacing body, because I happened to have the book in which these reactions are fully stated at hand, but exactly the same thing takes place with bromine.

x-q. 160. Then when the formula of alizarine $C_{14}H_8O_4$ was known, and when the formula of anthrachinone $C_{14}H_8O_2$ was also known, and the two were compared, wasn't it obvious that alizarine could be produced from anthrachinone, provided the substitutions in the well known way would operate when tried on the anthrachinone?

A. Not at all, from these formulæ. Thus, the formulæ do not inform us that anthracene differs from anthrachinone by the substitution of hydroxyl for hydrogen, but would be equally consistent with the supposition that it was simply an oxydized product, with its oxygen atoms combined, just as in anthrachinone. It was only
466 after these substitutions had been actually effected that the real structure of alizarine was known; but even assuming that we not only knew the formula but knew all that we know now about the structure of alizarine—in other words, that we knew that its molecule was correctly represented by the following figure—I adopt the hypothesis of Graebe and Liebermann, as given in their extensive paper in the Ann. der Chem. und Pharm., supplementary vol. 7—



it would by no means follow as a matter of certainty or, as I understand the word, "be obvious" that the introduction of just two and not more atoms of bromine would be possible, or if possible, could be effected without breaking up this molecule, so much more complex in its structure than any of those before acted upon; or that this body would allow the substitution of two atoms, and not, like the bichloronaphthaquinone, refuse to admit of the substitution of more than one.

x-q. 161. Do you mean to assert as a fact that the formula of alizarine $C_{14}H_8O_4$ and the formula of anthrachinone $C_{14}H_8O_2$ were not both known to Graebe and Liebermann before they converted anthrachinone into alizarine?

A. I have never asserted anything of the sort and, on the contrary, have no doubt that Graebe and Liebermann knew of a great many other substances which had the same formulæ.

x-q. 162. Then, knowing those formulæ and also knowing the fact that alizarine had been converted into anthracene by Bayre's process, did they do anything except subject anthrachinone to a well known process and observe the result, viz, alizarine. If so, what else did they do, so far as you understand the facts from the
467 histories which you have cited?

A. By a "well known process" I understand either the simple treatment of something in a given way, which is well known in itself, but without any reference to the effects or results of said treatment; as, for example, the process of heating, dissolving, fusing, or the like, or I should understand by "a well-known process" a process involving certain known effects in the body acted on; as, for example, the substitution of hydroxyl for hydrogen by the previous formation of a bromine compound, would be a well-known process wherever it had been applied. Now, in the first sense, Graebe and Liebermann used well-known processes when they heated anthrachinone with bromine; but, in the second sense, they did not use a well-known process, because prior to their experiment nobody knew that such a replacement was possible with anthrachinone.

x-q. 163. Do you mean to say that it was not a well-known process to use bromine or chlorine for the purpose of working a substitution of hydroxyl where such a substitution was desired?

A. I mean to say that it would be an *attempt* to use a well-known process in that sense. In other words, the simple heating with bromine or chlorine, for example, would be a well-known process in the first sense I have defined; but, until we knew whether the desired combination would take place, we could not even know that the process we aimed at had been effected at all.

x-q. 164. I am not asking a philosophical question, for I know that until the event has happened certainty cannot be predicated of it, philosophically speaking. The question of fact I asked is, whether, in 1868, it was not well known in chemical reactions that bromine or chlorine could be used as a means of substituting hydroxyl in combinations where it was desired to be such?

A. Sometimes, but not by any means always.

x-q. 165. Then, when Graebe and Liebermann used that process to substitute hydroxyl, they used a process which experience had shown to be adequate for the purpose "sometimes, but not always?"

A. Understanding by the word "sometimes" with some substances, and not merely on different occasions, I believe your statement is correct.

x-q. 166. Then, if Prof. Cooke had added to the words "the method was obvious," the statement that with some substances, however, it would not operate, he would have made a precise statement, as you understand the facts?

A. He would not. The expression, "the method was obvious," does not admit of being corrected in that way. Had he said the method to be tried was obvious he would have correctly expressed this part of the subject; but his expression, standing in the relation it does, implies that it was obvious not only that heating with bromine, and so on, *might* produce the desired result, but that the necessary reactions would follow, and would lead to the desired result.

468 x-q. 167. Is there any chemical reaction whatever, which has not already been made, of which certainty can be predicated in advance?

A. Yes, I think there are a great many, but they all involve a previous knowledge of a like reaction between bodies, one of which should be identical in both cases, and the others of which should be known chemical equivalents. Thus, having found that hydrogen could be replaced by hydroxyl in a naphthaline compound by the use of bromine and potash, we could safely predict the same thing as sure to occur with bromine and soda, or with chlorine and soda, or potash, or with any of the other bodies known to play the part of monatomic radicals in such reactions; but it would not follow that any of these agencies would be able to effect the same thing in some other hydro-carbons.

Adjourned to May 7th, 1878, at 11 a. m.

469 NEW YORK, *Sept. 20th*, 1878—11 a. m.

Met pursuant to notice. Present: Counsel, as before.

Examination of Prof. MORTON continued:

x-q. 168. In your 101st answer you said that, in your opinion, the report of Graebe and Liebermann at the Vienna exhibition does give a false color to the facts as you believe them to have existed, and does have the effect of enhancing the merit of the sulpho-acid process. The first statement by Graebe and Lieberman to which I call your attention is in these words: "Furthermore, there was much difficulty in transferring the above methods to a large scale," meaning by the word "methods" the bromine and chlorine methods of making alizarine.

Now, I ask you whether that statement was true or false when it was made in respect to what Graebe and Liebermann had then done, and whether you can refer the court to any published contradiction of its truth by either Graebe or Liebermann?

A. The accuracy of this statement depends, of course, upon the meaning we attach to the words taken in their existing connection. I should, therefore, in the first place, consider it necessary to carry on the quotation a little further, when it would read, entire, as follows (I here quote from the translation of the German report as made by a competent German scholar, Mr. A. Faber du Faur):

"Besides, considerable difficulties presented themselves as to carrying out the above-mentioned methods on a large scale: Graebe and Liebermann, therefore, entered connection with the Baden Alilin and Soda Works in Ludwigshafen, on the Rhine, the largest works in Germany, even on the continent. The first trials principally embraced the purification of anthracene, the manufacture of anthrachinone, and the practical application of the second above-mentioned bromine method, as the same, notwithstanding the great difficulties, still gave assurance that it could be used practically."

If this statement is understood to mean that the difficulty in transferring the process to a large scale consisted in the difficulty of obtaining sufficient quantities of anthracene, purifying the same,
470 and handling them mechanically so as to prepare anthrachinone and the other derivatives in large quantities, I consider that this statement was perfectly correct, and is consistent with other statements in the same report, as, for example, where it says:

"It was of importance, first, to become better acquainted with anthracene, the derivatives of which had only been examined by Anderson. The difficulty of obtaining anthracene was a great drawback in the beginning. The synthetic formation of Limpricht and Berthelot, also the formation from alizarine, were impracticable on a large scale. The material employed by Anderson could not be had, and, therefore, the first material had to be made from high-boiling tar in the laboratory."

Again, a little further on, in the same report, they say:

"One of the chief difficulties experienced was the fact that the raw material was not only unknown in commerce, but also in the tar industry, and it was difficult to say whether it could ever be obtained in sufficient quantity."

If, however, the passage you have quoted is understood to mean that Graebe and Liebermann failed when they tried to carry out the bromine process on a large scale, then it would give a false color to the facts, and would be inconsistent with the statements which I have quoted and with my personal knowledge that the process with bromine is an exceedingly easy and certain one—far more easy and certain than the sulphuric acid one in the laboratory, where I have tried both—and presenting no conditions which could offer any practical difficulties when worked on the large scale; the reasons which

have prevented its use being simply the question of economy between bromine and sulphuric acid.

The fact, to the best of my knowledge and belief in this connection, was that Graebe and Liebermann, in order to obtain material to work with and means of making large experiments, entered into connection with this large chemical works, who had in their possession a great quantity of crude anthracene and extensive facilities for working.

x-q. 169. Didn't you know when you answered this last question that anthracene had to be obtained, whether the bromine or sulphuric acid process was subsequently used or not, and that the difficulty you suggest in procuring it was the same whichever method might be employed in its subsequent treatment?

A. I did, but do not see that this fact would in any way affect my answer.

x-q. 170. The question is one of fact and not of opinion, and that question is whether Graebe and Liebermann did find much
471 difficulty in transferring their laboratory experiments to a large scale, as they state, or whether that statement is false in that regard. And if you say it is not true, refer the court to any publication made by Graebe and Liebermann which contradicts that statement.

I do not ask you for your opinion founded on your laboratory experiments, of what you think you could do on a large scale; all I ask has reference to what occurred before 1873, a statement of which was made by Graebe and Liebermann at the Vienna exhibition.

A. As I was not present at any of the experiments of Graebe and Liebermann, I can only answer your question of fact by reference to their statements, which statements I must interpret and understand by means of my own general knowledge of the subject. Aided by this, I say that I understand their statements to which you have referred as amounting to this: That they found difficulty in obtaining and purifying anthracene in quantity and in obtaining such facilities of large apparatus as would be necessary in conducting their experiments on a commercial scale, and therefore entered into connection, as they say, with the Baden Anilin and Soda Fabrik.

x-q. 171. You swore in reply to the 102d question that the statements made by Graebe and Liebermann at the Vienna exhibition and quoted in that question "are untrue or only partially true," and that they, or some of them, "conflict with statements made by Graebe, Liebermann and Caro at the time of their application for their English patent, or with the facts expressed or implied in their earlier publications."

My present purpose is to present to you each of the facts stated by them by itself, and to give you the opportunity to vindicate what you swore to in regard to them, and I shall proceed in regular order for that purpose.

The second statement by them is in these words:

"Originally the experiments were limited to the purification of

the anthracene and the winning of the anthrachinone by the second mentioned bromine method, because this, notwithstanding its difficulties, showed some hopes of success."

If you you please to substitute for that translation the one you say has been furnished you by some other person, I have no present objection. Now, what statement in that paragraph is either "untrue or only partially true," and in what publication by them is its truth denied?

A. Before answering your question proper I will explain certain points called for by your own preliminary explanation.

In my answer to question 102 I stated "that my attention had not been before drawn to this portion of the report of Graebe and Liebermann." My answer, given at that time, was therefore directed to the impression produced at the moment by the translation you then presented. Thus, for example, the first passage quoted by
472 you, namely, "Furthermore, there was much difficulty in transferring the above methods to a large scale," seemed for the moment to me to imply that difficulties connected with the essential character of the process presented themselves when they endeavored to carry it out on a commercial scale. Taking the statement in this sense, it would have conflicted with other statements, such as that contained in the declaration of Heinrich Caro, to which I have already made reference in my answer to question 132 of this record, where I find as follows:

"I returned to Mannheim immediately afterwards, and Mr. Graebe shortly after, in the month of May, 1869, came to Mannheim, and we then proceeded to carry out the said invention. We first used the original process as described in the said specification of the patent, No. 3850, 1868, and afterwards we carried out the same process, substituting sulphuric acid for the bromine originally employed."

I therefore consider that I was entirely right in saying at the time that the passage as quoted by you, and as then understood by me, contained statements untrue, or only partially true, in so far as they conflict with the statements made by Graebe, Liebermann, and Caro elsewhere. When, however, I had time to read over an accurate translation of the whole report, and to consider deliberately what the various phrases might mean when taken in connection with this larger context, I found that many of them might be naturally understood without any strained meaning or forced construction in such a way as to agree with the earlier statements of the same authors and with other portions of the same document. This is the case for example with the first phrase which you have quoted.

It is also true in reference to the second passage to which you refer, and this leads me to the formal part of your last question, in reply to which I would say, that, taking the passage as translated by you, and getting from it the impression that in the first place the experiments referred to were made prior to the connection with the Baden Anilin and Soda Fabrik, and resulted in experiments which

only showed some hopes of success, it would be untrue, or only partially true, and would conflict with the earlier publications of these authors, from which it appears that they were entirely successful in making artificial alizarine by this bromine process, and indeed carried it out on a commercial scale after their connection with the anilin works. If, however, I take the passage as translated by Mr. Faber du Faur, and understand it to mean that the first thing they took in hand on going to the anilin works was the purification of anthracene in large quantities, and the manufacture of the
473 bromine compounds on the commercial scale by a process which they already recognized could be used in this way I then find this no longer untrue or inconsistent with their other publications, or statements, such as the declaration of Caro, already quoted, where he says: "We first used the original process as described in the said specification of the patent," or with the letter from Liebermann, addressed to Badische Anilin and Soda Fabrik, dated Berlin, December 21st, 1875, in which he says:

"That Graebe and Liebermann, the inventors of the artificial alizarine production, were not by any means compelled to surrender their Prussian patent, as Reimann maintains, 'because they were unable to prove that their process could be practically carried out,' you, who have practised it for some time, know best yourselves," (referring to the Badische Anilin and Soda Fabrik.)

Also in the declaration of Charles Graebe, already referred to by me, I find the following:

"After the publication of that paper the said Charles Liebermann and I proceeded to endeavor to carry out the discovery then announced to practical purposes, and after a lengthened series of experiments and researches we arrived at the practical result we expected, which we then embodied in a specification, and applied for patents in various countries"

Adjourned to Sept. 21st, 1878, at 11 a. m.

NEW YORK, *September* 21, 1878.

Met pursuant to adjournment.
Present—Counsel as before.

Examination of Prof. MORTON continued:

x-q. 172. You have quoted from what is a private letter from Liebermann in 1875. Did you understand that when he used this expression, "you who have practised it for some time know best yourselves," he was contradicting his Vienna report?

A. If I supposed that the Vienna report stated that the bromine process had never been practically carried out at the Anilin works prior to the adoption of sulphuric acid as a substitute for bromine, I should regard this as a contradiction or correction of the same. But, as I now believe, that the Vienna report, correctly translated, and taken as a whole, does *not* contain any such statement, I do not regard this as a contradiction.

474 x-q. 173. As you understand the English language, is it your opinion that the words in the Vienna report, in which it is said that the bromine method "notwithstanding its difficulties showed some hopes of success," are, in fact, a statement that that method was in successful and practical operation, and was not merely an experimental attempt for the purpose of introducing it into successful and practical operation?

A. The words you now give would undoubtedly convey the impression that the method had only been tried with very unsatisfactory results. But I am informed and believe that they are not a correct translation of the original German report, but that the passage referred to correctly rendered would read as follows:

"The second above-mentioned bromine method, as the same, notwithstanding the great difficulties, *still gave assurance that it could be used practically.*"

This, moreover, is immediately followed by these words:

"The latter was then dropped," etc., which, as I understand, indicates that it was carried on before it could be dropped.

I have never stated that the Vienna report, in the passage to which you refer, states that the bromine method was in successful and practical operation. What I have stated is, that the Vienna report, in this place, does *not* state that the bromine process had never been practically carried out at the Anilin works prior to the substitution of the sulphuric acid for bromine, which, as I understand the English language, is a very different matter.

x-q. 174. Assuming your version of the translation to be correct, do you understand that the words "still gave assurance that it could be used practically" convey the meaning that, in fact, the bromine method had been practically used at the time the experiments were dropped?

A. I do not understand, nor have I asserted, that these words convey that meaning. What I do understand and have asserted is, that they do not contradict it, and are not inconsistent with such a state of facts elsewhere stated and implied.

x-q. 175. The next statement of Graebe and Liebermann is in these words, "the latter" (i. e., the bromine method) "was dropped as soon as the observation was made that the alizarine could be made more simply by means of anthrachinone sulpho-acids."

As you understand it, is that statement untrue, or only partially true, or contradicted by Graebe and Liebermann in their earlier publications?

A. Even as you give it, the words seem to me to mean that the bromine process was in operation for a short time, but was dropped when it was found that the alizarine could be made more
475 easily by the use of sulphuric acid in place of bromine. When, however, I substitute for your translation that prepared by Mr. Faber du Faur, which reads as follows: "The latter (meaning bromine process) was then dropped when the observation that the alizarine could be manufactured also by the aid of anthrachinone sulpho

acids showed a better and simpler way," it seems to me unquestionable that this paragraph distinctly implies that the alizarine had been manufactured, or commercially produced by the bromine process just as it was afterwards by the sulphuric acid modification. At all events, I do not find anything in this which contradicts the statements elsewhere made, that such manufacture was carried out, and therefore I do not find this statement untrue, or only partially true.

x-q. 176. The next statement is in these words: "Graebe and Liebermann had originally attempted to obtain anthrachinonesulphoacids by acting on anthrachinone with sulphuric acid, but the temperature they employed were not high enough, being not greater than those generally employed in the preparation of sulpho acids. They had also been misled by the observation that anthrachinone could be sublimed unchanged from strongly heated sulphuric acid. Therefore, they hoped little from sulpho acids, and gave all their attention to improving the above methods," i. e. bromine and chlorine.

Will you point out to the court where Graebe or Liebermann have ever said, in print, or in publication of any kind, that this statement is either untrue or only partially true, or ever contradicted it by any statement inconsistent with it which has been published in any printed publication made by them or by their authority?

A. I have never asserted, nor do I intend to assert, that Graebe or Liebermann "have ever said, in print, or in publication of any kind, that this statement is either untrue, or only partially true, or even contradicted it by any statement inconsistent with that which has been published in any printed publication made by them or by their authority."

What I have asserted before in my answer to q. 102, and now maintain, is that what you have quoted, in so far as it conflicts with the statements made by Graebe, Liebermann and Caro at the time of their application for their English patent, or with the facts expressed or implied, in their earlier publications, is untrue, or only partially true. As, from your statement in your q. 171, where you say "my present purpose is to present to you each of the facts stated by them, by itself, and to give you the opportunity to vindicate what you swore to in regard to them, and I shall proceed in regular order for that purpose," I understand that it is this which you intend to inquire into, I will say the passage you have quoted, even if
476 the last sentence in it be corrected so as to read: "Therefore they had *at first* expected *too little* from sulpho acids, *and in their further trials had mainly endeavored to perfect the above methods*"—(I italicize the corrected words)—seemed to me, when I first heard it, to mean, and still seems capable of meaning, that Graebe and Liebermann had made trial with a view of substituting sulphuric acid for bromine, and had obtained such results as convinced them that this process was impracticable, the sulphuric acid refusing to combine with the anthrachinone, and that they had therefore abandoned all idea of such a process for the manufacture of alizarine, leaving it for Caro to discover.

Now, as thus understood, I consider that this statement is inconsistent with the declaration of Caro, in which he says:

"3. As the chemist of the said company, it was of importance to consider the best and most economical modes of carrying the said invention into practice, and whilst in Berlin in the month of April last I had many conversations and discussions with Messrs. Graebe and Liebermann upon that subject; in the course of such conversations the use of sulphuric acid in place of bromine in the carrying out of the said invention was frequently proposed."

Also with the declaration made at the same time with the above, in connection with the application for an English patent by Charles Graebe, in which he says:

"I concur in the statements made by him (Caro) at paragraphs 2, 3 and 4 of the said declaration, and particularly in his statement that the substitution of sulphuric acid for bromine or chlorine in the carrying out of the invention into practice was frequently proposed and discussed at our meetings in Berlin in the month of April, 1869."

The statement quoted from the Vienna report would also seem to conflict with the assertion made in their application for an English patent, June 25th, 1869, in which they say:

"We have now discovered that a similar result (the production of alizarine from anthracene) may be obtained by substituting sulphuric acid for bromine or chlorine in the above process."

In fact, the whole patent is based on a joint discovery made by Caro, Graebe and Liebermann.

Also, in an article published by Graebe and Liebermann, recounting their investigations connected with the production of
477 artificial alizarine, published in the Annalen der Chemie und Pharmacie, supplementary vol. 7, March 17, 1870, p. 303, they say as follows:

"Alizarine can also be obtained by converting anthrachinone into anthrachinonebisulpho-acids, as this, on fusion with hydrated potash, exchanges the two sulphuric acid radicals for hydroxyl. Further details we reserve."

No mention whatever is made of Caro in this connection, but they speak of this process exactly as they do of their own original discovery.

Again, in another volume of the same journal, viz., vol. 160, for 1872, at p. 130, in a further communication by Graebe and Liebermann, they say as follows:

"As we first, in common with Caro, found anthrachinone, on heating with sulphuric acid over 200°, to be converted into sulpho acids, which, on melting with hydrate of potash, furnish alizarine."

In the seeming conflict of statements which thus appears to exist between the Vienna report and these various other publications, it seems to me that the earlier and more emphatic assertions made under oath, as in the declarations and patent, must be accepted; and the Vienna report, in so far as it conflicts with these, must be con-

sidered untrue or only partially true. This conclusion is confirmed in my mind by the circumstance that a gentleman who met Mr. Graebe during the last summer has informed me that Mr. Graebe told him that the passage you have quoted, and the next succeeding it in the Vienna report, was written by Mr. Caro. The proof, having been sent to him as a matter of courtesy by Graebe, was returned with this passage modified into its present form; that when this was shown to Mr. Liebermann he entirely disapproved of it, and that a rather angry correspondence ensued between Messrs. Liebermann and Caro, during which Graebe published the report with the passage as arranged by Caro, to put an end to the controversy, and with the feeling that he and Liebermann were so unquestionably the discoverers of everything essential in the process that they could afford to let Mr. Caro say what he pleased on this matter, even though they did not regard it as correct.

(Counsel for defendant now requests counsel for complainant to suppress all that part of the last answer in which the witness attempts to influence the case by swearing to what some other person had told him he had heard Graebe say, the same not being in response to the question, and an unjustifiable attempt to introduce into the case what is obviously not proper.

478 Complainants' counsel declines to have the same stricken out of the case unless all the questions of defendant's counsel relating to the Vienna report be stricken out also; and he calls the attention of defendants' counsel to the fact that the range of inquiry by defendants' counsel, as to the true meaning of some miscellaneous statements of Graebe and Liebermann, authorizes complainants and authorizes the witness to give all the information in their possession as to what Graebe and Liebermann have said. Complainants' counsel gives notice to defendants' counsel that a motion will be made at the final hearing herein to strike out from the record all the cross-examination which relates to the Vienna report.

Counsel for defendant will move to suppress the answer.)

x-q. 177. The next statement by Graebe and Liebermann is this:

"This mistake was avoided, and the modification of the synthesis of alizarene, which forms the basis of the industry of to-day, was found first by Heinrich Caro. * * * Caro first noticed that anthrachinone, if heated with sulphuric acid to above 200°, would give sulpho-acids, which, on fusing with hydrate of potash, formed alizarine, the same as the bromine compound. Perkin noticed the same fact shortly after or at about the same time."

If you say that that is false, or only partially true, point out to the court any published contradiction of it by Graebe or Liebermann; and I now request you not to encumber the record by detailing conversations with your employers or others in respect to what Graebe may have said on the subject.

A. If this passage is understood to mean that the modification of the process by the substitution of sulphuric acid for bromine was a discovery made by Caro individually, and not by Graebe, Lieber-

mann, and Caro conjointly, it is contradicted by the English patent, taken out by Caro, Graebe, and Liebermann, which I have quoted in my last answer; also by the declarations of Caro and of Graebe, which I have also quoted in the last answer, and is also contradicted by the quotations from the Annalen der Chemie und Pharmacie, given in my last answer, and forms, as I believe, part of the matter inserted in the Vienna report by Mr. Caro. It is, therefore, in my opinion, if so understood, untrue.

x-q. 178. Point out to the court which part of all you have referred to contradicts the statement that Graebe and Liebermann had attempted to use sulphuric acid and failed because of the low
479 temperature employed, and that Caro discovered the necessity of high temperature and the effect it would produce.

A. 1. In the first place their English patent, in which they say: "We have now discovered that a similar result" (the production of alizarine from anthracene) "may be obtained by substituting sulphuric acid for bromine or chlorine in the above process."

2. In the second place, Caro, in his declaration which I have already frequently quoted, says that while discussing with Messrs. Graebe and Liebermann, in his first interviews with them, the best and most economical modes of carrying their invention into practice, the use of sulphuric acid in place of bromine in the carrying out of the said invention was frequently proposed.

3. Thirdly, this declaration is specifically confirmed in the similar declaration of Graebe, who also adds: "The substitution of sulphuric acid for bromine or chlorine in the carrying out of the invention into practice was frequently proposed and discussed at our meetings in Berlin, in the month of April, 1869."

4. Fourthly, in their articles in the Annalen der Chemie und Pharmacie, which I have already quoted, in the first of which they speak of this among their own discoveries, and in the second of which they say:

"As we first, in common with Caro, found anthrachinone on heating with sulphuric acid over 200° to be converted into sulpho acids, which, on melting with hydrate of potash, furnish alizarine."

Adjourned to 1878, at

NEW YORK, *Sept.* 30, 1878.

Present—Counsel as before.

Examination of Prof. MORTON continued:

x q. 179. Do you mean to say that, in your opinion, Graebe and Liebermann or either of them, in any of the references you have made, contradict the statement in their Vienna report, that they attempted the use of sulphuric acid and failed in producing alizarine by that means because they did not know the proper temperature to be used?

A. If the statement to which you have referred, in the Vienna report, is understood to mean that Graebe and Liebermann had

made none but unsuccessful attempts to prepare anthrachinone sulpho acids prior to the time that this was successfully and independently accomplished by Caro, I then consider that such a statement would conflict with those which I have quoted. If, however,
480 it is understood to mean that Graebe and Liebermann in some of their earliest experiments, when they were working with very small quantities of anthracene and saw no way of procuring more, tried an experiment with sulphuric acid, and being discouraged by the difficulties encountered, as the report says, "hoped too little from sulpho acids, and gave all their attention to improving the above methods" (i. e., the bromine methods); these being such as would show their progress distinctly even on their first trial, as I know from experience—then I think this much of the statement might be reconciled with the quotations which I have given on the assumption that they (Graebe and Liebermann) still regarded the method as requiring only further experiment to fully develop it, and that, as soon as they obtained more anthracene, they themselves, together with Caro, or without him, made further experiments which resulted in a complete and manifest success.

x-q. 180. In the Vienna report Graebe and Liebermann say:

"Caro first noticed that anthrachinone, if heated with sulphuric acid to above 200° would give sulpho acids which, on fusing with hydrate of potash, formed alizarine, the same as the bromine compound."

Is that statement ambiguous or definite to your mind?

A. It is definite.

x-q. 181. Is it contradicted by anything which has been signed and printed by Graebe and Liebermann, that you know of?

A. It is. In the first place, in an article by Graebe and Liebermann in the Annalen der Chemie und Pharmacie, 1872, vol. 160, p. 130, I find as follows:

"As we first, in common with Caro, found anthrachinone on heating with sulphuric acid over 200° to be converted into sulpho acids, which, on melting with hydrate of potash, furnish alizarine."

Again, about two years earlier, in a supplementary volume of the same journal, published March 17, 1870, vol. 7, p. 303, in an article also by Graebe and Liebermann, they say as follows:

"Alizarine can also be obtained by converting anthrachinone into anthrachinone bisulpho acids, as this on fusion with hydrated potash exchanges the two sulphuric acid radicals for hydroxyl. Further details we reserve."

In the first of these two quotations we have almost in the same
same words the same discovery claimed for Caro (as I believe by himself) in the Vienna report, claimed by Graebe and Lieb-
481 ermann for themselves in common with Caro. In the earlier publication, which I have quoted last, it is made evident that the important fact that the sulpho acid could be made and converted into alizarine was known to Graebe and Liebermann and claimed by them as one of their own discoveries.

x-q. 182. Then as you understand the use of language, the last quoted statement by Graebe and Liebermann in 1870 of what had occurred in 1869, is not a mere statement of the fact that sulphuric acid could be used in the manufacture of alizarine in the manner suggested, but is a claim that they and not Caro were the discoverers and inventors of that method?

A. I consider it to be not a claim but a statement that the facts therein stated were discovered by the authors of the article themselves, but not of necessity involving that Caro had nothing to do with it; but only as implying that his connection was no other than that of an assistant or coadjutor, so that they might in a scientific way regard themselves as the discoverers leaving Caro, perhaps, to regard himself as a joint discoverer.

x-q. 183. Is anthrachinone a dyestuff or in any way effective for dyeing if any of it remains associated with the alizarine produced by the sulpho-acid process?

A. It is not.

x-q. 184. It does remain in more or less quantities associated with the alizarine, does it not?

A. It does.

x-q. 185. Is monoxanthrachinone a dyestuff?

A. It is not; but it performs a useful office, as I believe, when associated with the dyestuffs constituting artificial alizarine.

x-q. 186. State what function it performs and how you made that discovery.

A. It aids in keeping the whites clean. It is well known to dyers and printers generally that the addition of various matters not themselves useful as dyestuffs have this effect when added to very pure preparations of madder, and I found myself that artificial alizarine containing oxyanthrachinone among other things when used for dyeing mordanted cloth gave clean whites, while the sublimed or otherwise carefully purified alizarine, when similarly used, stained or colored the white or unmordanted parts of the cloth.

x-q. 187. Did you ever try the experiment of using alizarine made by the sulpho-acid process with and without any monoxanthrachinone in it, all other things being the same, for the purpose of ascertaining the effect of that ingredient on the whites of cloth or for any other purpose? If so, when and where was that experiment made. State the process by which you removed the monoxanthrachinone to enable you to try the experiment.

482 A. I know of no process by which the monoxanthrachinone can be removed from artificial alizarine without removing other substances at the same time; therefore, I have never made any such distinctive experiment as you describe, nor do I mean to claim any such precise knowledge on the subject as your question suggests. I mean to state it as my opinion, founded on analogy and on the observation, that while purified alizarine stains the whites, the commercial product containing oxyanthrachinone and other matters which have not yet been isolated and studied does *not* stain the

whites; that oxyanthrachinone is one of the substances present in artificial alizarine which exerts this protective influence.

x-q. 188. Monoxanthrachinone can be isolated, can it not?

A. It can.

x-q. 189. It is a by-product in the production of alizarine, is it not?

A. That depends upon what we mean by the production of alizarine. If we mean the production of the commercial dyestuff, then in so far as this may be useful in the product I should hardly call it a by-product. If our object in the process is only to obtain chemically pure alizarine, then, of course, the oxyanthrachinone is a by-product.

x-q. 190. Is the anthrachinone which you find in commercial alizarine a by-product as you understand the patent?

A. If it is in fact a product of the process and not simply a portion of material which has not gone through the process I should consider it a by-product.

x-q. 191. Well, what is it in fact, as you understand the patent and the process? Can't you answer this without an "if"?

A. On reflection I am disposed to think that as this is a substance which Graebe and Liebermann do not claim to have discovered or to have made for the first time, and as it is simply the product of the first step in their process, I do not think it can be called a product of their process.

x-q. 192. Do they claim to have discovered monoxanthrachine? If so, point out in the patent where that claim is.

A. They do not claim specifically anything about it. But as it was not known before their invention and was first discovered in the product of their process, I consider it to be one of the new things which they were the first to produce and therefore to be one of the products of their process.

x-q. 193. What is the constitution of monoxanthrachinone, and give your authority for the statement?

A. Its ultimate composition as stated by Graebe and Liebermann in their Vienna report on page 60 of the translation of the same made by Mr. William Rupp under the direction of Prof. Charles F. Chandler, is:

$$C_{14}H_7 \begin{cases} O_2 \\ OH \end{cases}$$

483 This composition was determined by Graebe and Liebermann, and also by Liebermann alone.

x-q. 194. Do yon know anything about its composition, excepting as you have learned by reference to the authorities quoted?

A. I do not.

x-q. 195. Graebe and Liebermann say of it:

"Its presence in artificial alizarine does not change the colors in dyeing, but is injurious in reducing the real percentage of coloring matter because it forms no insoluble lake."

They also say:

"The oxyanthrachinone forms after re-crystallizing or subliming gold-yellow needles or flakes, gives blood-red solutions with alkalies, and produces no colors on mordanted cloth because its alumina and iron salts are soluble."

Do you know any publications by them or by any other recognized authority denying the truth of either of those statements? If so, refer to those publications.

A. I know of no publications denying the statements you have quoted, nor do I find them inconsistent in the smallest degree with anything I have stated in this examination. I have never asserted that oxyanthrachinone changes the colors produced by artificial alizarine in dyeing, or that it produces any color on mordanted cloth. What I believe to be the fact is that it aids in keeping the whites clean. Regarded, therefore, simply as part of the dyeing elements in artificial alizarine, it would be injurious, in so far as it reduces the percentage of real coloring matter; but for all that, it may well be a practically useful part of the product to the dyer and calico printer.

x-q. 196. Do you know of any writer or any publications by whom or in which it is asserted that oxyanthrachinone is anything but what Graebe and Liebermann declare it to be, an injurious by-product of their process for producing alizarine?

A. In the first place, Graebe and Liebermann, in the passage to which you refer, as I presume, do not declare it to be an injurious by-product in the sense which those words naturally convey. The passage in their Vienna report, to which you have already referred, when accurately translated, would be as follows, as I am informed and believe:

"It acts in so far injuriously as it diminishes the percentage of real coloring matter."

This I consider to mean, not that it is in any sense, as your question implies, an actively injurious by-product, but simply that
484 in so far as it takes the place of a corresponding amount of coloring matter it is injurious in reducing the percentage of the same. This statement of the Vienna report I find nowhere contradicted.

x-q. 197. The question I wish answered is whether you find it stated anywhere either that this substance is not a by-product of alizarine, or that it is a beneficial substance when associated with alizarine for the purpose of dyeing.

A. This, which is quite a different question from the former one, I answer readily as follows:

I do not find any statement that this substance is not a by-product of alizarine, nor that it is a beneficial substance when associated with alizarine for the purpose of dyeing.

x-q. 198. Or for the purpose of keeping the cloth white?

A. Nor for the purpose of keeping the cloth white. This last is my own conclusion, founded on my own knowledge and observation.

x-q. 199. Do you really mean to swear that it is a fact within your

knowledge that the oxyanthrachinone found associated with alizarine does keep the unmordanted cloth white when used in the dye-beck or dye-bath?

A. It is my belief that oxyanthrachinone, together with the other bodies present in commercial artificial alizarine, and which are separated from it at the same time with the oxyanthrachinone, by the treatment described by Graebe and Liebermann in their Vienna report, (which is inserted between the two paragraphs which you quoted from the same in your question 196,) acts as a means of keeping the whites clean.

x-q. 200. It is a question which can be reduced to certain knowledge whether it does so act or not. Is not that true?

A. It might, or it might not. The only way in which it could be determined absolutely, as far as I see, would be by removing oxyanthrachinone alone from commercial artificial alizarine and then comparing the effect of the article thus deprived of this one substance, in dyeing cloth, with the effect of the commercial product. No process for effecting such a separation is known to chemists, as far as I am aware.

x-q. 201. Then so far as you know there are no means of ascertaining whether this substance produces any effect on the whites of cloth dyed with artificial alizarine? If you say that there are any such means describe them, that the experiment may be tried.

A. There are none which will decide this question absolutely.

x-q. 202. Do you mean to say that artificial alizarine, having in it oxyanthraquinone, leaves the whites freer from color than madder preparations having in them no oxyanthraquinone?

A. I do not. There are plenty of things besides oxyanthraquinone that perform this same function; and if these are present, as they are in many preparations from madder, they will effect this result equally well.

485 x-q. 203. Isn't it true also that the amount of this by-product that will appear in the manufacture of alizarine depends upon the heat applied and varies according to circumstances?

A. It undoubtedly does vary, but that heat is the only cause of variation I should hesitate to assert.

x-q. 204. Is it not also true that the best result of the manufacture is that which makes the least of this by-product and the most alizarine considering this product to be the intermediate between anthraquinone and alizarine?

A. That depends upon whether the object is to produce chemically pure alizarine as nearly as possible pure, or whether it is desired to produce rather a product rich in the isomeric purpurines, such as anthrapurpurine and iso or flavopurpurine. It must also be borne in mind that these reactions do not in fact occur as they are represented partially in formulæ; but that not only one set of changes—such, for instance, as that to which you allude in this case—will go on, forming theoretically the body chemically pure alizarine only, but that other substances are present and other products

will result; so that I do not think we can say that the process which produces the least oxyanthraquinone would be the best for the production of commercial artificial alizarine.

Adjourned to Friday, Oct. 4, at 1 p. m.

NEW YORK, *Oct. 5th*, 1878.

Present—Counsel as before.

Examination of Prof. MORTON continued:

x-q. 205. Is not oxyanthrachinone the product of an imperfect oxydation of anthrachinone while it is undergoing the process of being converted into alizarine, in which last named condition it has one atom more of oxygen than in the intermediate stage?

A. If by alizarine in this question you mean chemically pure alizarine, your statement would be in a certain sense true, but indefinite or wanting in chemical precision. I should correct it as follows: Oxyanthrachinone is the product of a reaction in which one atom of hydrogen in anthrachinone is replaced by one molecule of hydroxyl, and if the same reaction were carried on so that another atom of hydrogen were replaced by hydroxyl, the product might be alizarine, or it might be one of the isomers of alizarine, such as anthraflavic acid or isoanthraflavic acid.

x-q 206. Graebe and Liebermann, in their Vienna report, say of this substance that "its composition is intermediate between that of anthrachinone and alizarine," and they give these three
486 formulas to represent technically that statement:

$C_{14} H_8 O_2$	$C_{14} H_7 \left\{ \begin{matrix} O_2 \\ OH \end{matrix} \right.$	$C_{14} H_6 \left\{ \begin{matrix} O_2 \\ (OH)_2 \end{matrix} \right.$
Anthrachinon.	Oxyanthrachinon.	Alizarine.

Now, do you mean to say that that is not a true statement whether considered as a general or a special one?

A. This statement is true as far as it goes, and agrees perfectly with my statement made in the last answer; but does not agree with the statement made in your previous question. The context shows that Graebe and Liebermann when they give the formula of alizarine in this place and refer to it, are using the word and formula to indicate chemically pure alizarine only; and their method of writing the second formula shows that they intended to point out that the oxyanthrachinone was not formed as you say by an oxydation of anthrachinone, but by a substitution of hydroxyl for hydrogen. They do not say that alizarine is the only product which could be formed by the substitution of another hydroxyl; and as they recognize the existence of at least one isomer of alizarine, namely, anthraflavic acid, in the very next article of their report, they, no doubt, did not mean to state that oxyanthrachinone might not be an intermediate step between anthrachinone and that body.

x-q. 207. Isn't it true that anthrachinone has two atoms of oxy-

gen while oxyanthrachinone has three atoms of oxygen, each having fourteen atoms of carbon and eight of hydrogen, so far as you know anything about it?

A. This is undoubtedly true, but by no means expresses the whole truth as to what is known by chemists generally concerning the difference between these two bodies. We know that the oxygen is not combined by simple addition to the anthrachinone, but replaces an atom of hydrogen while it is itself combined with an atom of hydrogen. This is fully indicated, as I have already shown, by the method of writing the formula. Had the change been one which could have been correctly described as an oxydation of anthrachinone, it would have been written C_{14} H_8 O_3, which, if applied to this substance, would here be only what chemists call an empyrical formula, that is, one giving simply the relative numbers of the various atoms without any suggestion as to their mode of arrangement, the deviation of the body, or anything else, which is expressed in what is here given, and is known among chemists as a "rational formula."

x-q. 208. I haven't asked you to give the hypotheses which at present are entertained by some chemists as to the mode by which the atoms composing a molecule are supposed to be added or subtracted in chemical reactions; the question is simply as to the
487 number of atoms supposed to be contained in the molecules of the different substances; and in that view I ask the next question: Whether the supposed molecule of alizarine does not contain one atom more of oxygen than the supposed molecule of oxyanthrachinone?

A. It does; and so also does the supposed molecule of anthraflavic acid and iso-anthraflavic acid. Also the supposed molecules of zanthopurpurin, frangulic acid, anthraflavone, chinizarin and chrysazin.

x-q. 209. What do you know about the composition of any of these substances which you have last enumerated, and where did you derive your knowledge?

A. I know from the published researches of various investigators that they all have the same ultimate composition, or would be expressed by the same empyrical formula as alizarine. I have separated out several of them, and thus know that the physical and chemical properties of these are very different from those of alizarine.

x-q. 210. Have you any knowledge yourself of their chemical constitution as expressed by the rational formulas which you say correctly describe them; if so, describe the process by which you made that discovery?

A. I have that knowledge which is possessed by every well instructed chemist at the present day, and which is found in all modern text-books of chemistry in which such bodies are mentioned. I was not the discoverer of these relations which have been evolved by the labors of a multitude of able men from the time of Keckule, who laid the foundation for modern chemistry, to the present day. Among

these, none are more remarkable than those of Graebe and Liebermann, which led them on the basis of such views of the arrangement of atoms to discover the structural relations between anthracene and alizarine, which led to their invention of the new dye-stuff —artificial alizarine. This discovery was as directly the result of this theory, as to the arrangement of the atoms, as was the discovery of Neptune a result of the theory of gravitation.

x-q. 211. I haven't asked you to pronounce a eulogy on Graebe and Liebermann, nor to give a history of modern chemistry. You have sworn that the five substances you have enumerated, namely, zanthopurpurine, frangulic acid, anthraflavone, chinizarn, chrysazin, had the same number of atoms, of the same character, as alizarine had. I asked you whether you knew that to be so of your own knowledge; if not, who was your authority for so stating; and to that question I ask an answer. If the statement is made in text-books of chemistry, refer me to that text-book. If it is in the published researches of some chemist who entertains such opinions, name the chemist who thinks so, and where he has published it.

A. I only chance to have with me at the present two books
488 touching on this subject; one being the Vienna report, from which I have already quoted, and the other a translation by the well known chemist, William Crookes, F. R. S., etc., of the treatise on "*Anthracen, its constitution, properties, manufacture, and derivatives, including artificial alizarine, anthrapurpurin, etc., by G. Auerbach,*" 1877.

In this work, on page 167, I find as follows:

"*The Isomers of Alizarin.*"

(The word isomers means bodies whose ultimate composition is the same, *i. e.* which would be represented by the same empyrical formula.)

"According to the formula of anthraquinon now universally assumed as correct, ten isomeric bioxyanthraquinons are possible," (alizarine is a bioxyanthraquinon) "of which nine are known, although not with sufficient accuracy. These are anthraflavic acid, isoanthraflavic acid, anthraxanthic acid, alizarin, quinizarin, chrysazin, frangulic acid, xanthopurpurin and isalizarin."

I here find the five substances whose names I quoted from Graebe and Liebermann's Vienna report all mentioned,—when we know that the word spelt in one case "chinizarin" is in the other case "quinizarin," and that the substance mentioned by Graebe and Lieberman as "anthraflavon" has since been shown to be a mixture of anthraflavic acid and iso-anthraflvic acid named in the list given by Auerbach.

After this general enumeration, the same author proceeds to describe these various substances in great detail, giving the same empyrical formula, $C_{14}H_8O_4$, for each of them, while showing by his description that each of them is an entirely dissimilar body, many of them, for example, having no dying properties recognizable in the

usual way. This book is essentially a compilation, and at the end, under the title "Bibliography," I find twenty-one pages of references, arranged alphabetically under the names of the different substances, giving the authors who have investigated the same, and the dates and places of publication of their papers. Thus, on page 237, under the title "Anthraflvic Acid," we have twenty references. On page 238, under "Anthraflavon," we have two references; and so on. I do not suppose that it is desired that I should go into the quotation of these, but in my note-book I have brief abstracts from all the more important ones which I have consulted. I have no text-books on organic chemistry with me, but I have no doubt that in "Watt's Dictionary," the German work recently published by Fehling, the late edition of Schorlemar, or "Fowne's Chemistry," most or all of these bodies will be found mentioned. And undoubtedly, wherever they are mentioned in recent works, their empyrical formulæ will be found to be identical.

My knowledge of the ultimate composition of these substances is derived from the authorities to whom I have referred, in a
489 general way, above. As I have already said, I have separated out and experimented with several of them so as to be familiar with their physical and chemical properties, including their behavior in the dye-bath; but have never thought it worth while to make what is called "a combustion" or ultimate analysis of them. As this having been once done by competent chemists, it would be a mere waste of time to repeat it.

x-q. 212. In the Vienna report Graebe and Liebermann say that "in the soda fusion it" (*i. e.* oxyanthrachinon) "is further oxydized to alizarine, and therefore forms an intermediate product between mono-sulpho acid and alizarine."

What stage of the process is referred to in that statement by the terms "in the soda fusion?"

A. That step of the process in which by fusion with soda the introduction of hydroxyl molecules into the anthrachinone is accomplished. As the phrase stands here, it might convey the idea that oxyanthrachinone existed prior to any fusion with alkali; but it is evident to any one familiar with the subject that what he means is, that when either the anthrachinon sulpho-acids or the corresponding bromine compound is fused with caustic soda or potash, as described in his patent. At first, before the temperature gets very high, some oxyanthrachinone is formed, which, as the same fusion goes on and the temperature rises, is converted into alizarine.

x-q. 213. Isn't it therefore true that this substance is simply an intermediate product in the process of producing alizarine, and that its conversion into alizarine in that process is effected by the increased heat used in the fusion and necessary to be used in order to produce alizarine?

A. What I should say is this: When the process of Graebe and Liebermann, either with bromine or with sulpho-acids, is carried out

in the soda fusion at the beginning of the reaction, some oxyanthra-$C_{14}H_5\begin{cases}O_2\\OH\end{cases}$ chinon is formed, and this by further heating and at a higher temperature reacts with more alkali, so as to form, at the same time with other things, more or less of chemically pure alizarine, which is one of the dyeing elements constituting the final product. In such a sense as is consistent with this, your statement is true.

Adjourned to Thursday, October 10th, 1878, at 11 a. m.

490 NEW YORK, *October 10th*, 1878.

Present—Counsel as before.

Examination of Prof. MORTON continued:

x-q. 214. Give the processes exactly, so that they can be repeated, by which you produced what you supposed to be two distinct bodies, one of which you called anthrapurpurine and the other isopurpurine.

A. By making the substance known as bibromanthrachinone, according to the second mentioned method for producing the same—given in the patent of Graebe and Liebermann—heating the same with caustic soda or a mixture of caustic soda and caustic potash and a little water in the manner described in the same patent, dissolving the product in water and decomposing by hydrochloric acid. The yellow flocks or yellowish floculent precipitate proved, on examination, to consist of a substance answering in physical and chemical properties to chemically pure alizarine, of another answering in chemical and physical properties to that first isolated and described by Perkin and named by him anthrapurpurine, and of another substance corresponding in chemical and physical properties with a substance which was first separated in an impure state (as it now appears) by G. Auerbach, and named by him isopurpurine. The recent investigations of Rosenstiehl, published in the "Bulletin of the Chemical Society of Paris," May 5th and May 20th, 1878, taken in connection with those of Schunck and Roemer and my own observations, show that this isopurpurine as extracted by Auerbach's method was not pure, but consisted mainly of the substance independently studied by the last mentioned authors and named by them flavopurpurine, mixed with some anthrapurpurine and some alizarine. In the light therefore of this new knowledge acquired since this subject was last referred to in this examination, which was some time prior to May, 1878, I should say that the substance which I have previously called isopurpurine would be more correctly named flavopurpurine.

x-q. 215. Was this production by you performed in test tubes?

A. It was not.

x-q. 216. Describe the apparatus, general dimensions, and quantities of material used, and the time occupied, so that the experiment can be exactly repeated.

A. I used in these experiments a silver vessel having the general

form of a thimble, but much larger, being about 2½ to 3 inches deep, and about 1¾ inches in diameter; this was immersed in a oil bath, heated by a Bunsen burner. The quantity of material used was about 10 grammes, equal to 150 grains of bibromanthrachinone, mixed with three times that weight of caustic soda or a mixture of caustic soda and potash and as much water as was necessary
491 to dissolve the alkali. The time occupied varied on different occasions, but was usually about an hour.

x-q. 217. Did you try the experiment by following the English patent of Caro, Graebe & Liebermann, known as the sulpho-acid process?

A. I tried that process many years ago, before I was called as a witness in this case, and was unsuccessful in obtaining any product which I could recognize as alizarine. I soon after took up the bromine process and found no difficulty with it.

x-q. 218. Describe the apparatus used by you in the bromine process, in producing bibromanthrachinone, specifying the quantity used and the time occupied.

A. In the first place I prepared tetrabromanthracene by the method usually followed, and which, I believe, is essentially that described by Anderson, to whom the patent refers. Of this I took about an ounce or so, and placed it in a glass retort of about one quart capacity; this was placed in a sand or water bath, so that it could be conveniently and gradually heated. Nitric acid was added, to the amount of about five times the weight of the tetrabromanthracene; the heat was kept at about 100° C, as long as the orange vapors of bromine were given off. By this means the tetrabromanthracene was converted into bibromanthrachinone. I did not distill off the nitric acid, as the economy effected by saving it was not worth the time required, but I simply washed the product with water and purified it by crystallization from benzole. The time occupied in this operation of converting the tetrabromanthracene into bibromanthrachinone was about half an hour.

Re-direct:

Re-d. 219. You refer in your answer, + 214, to some additional information gained by you in relation to isopurpurine, since you were asked about that substance in this examination, some time prior to May, 1878. Please state what additional facts relating to that body have come to your knowledge, and also state how you know them.

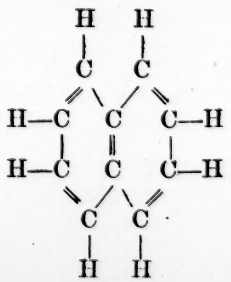
A. In the first place, when the researches of Schunk and Roemer were first published, the great similarity between the substance which they had isolated, and called flavopurpurine, and the material which I had obtained by following Auerbach's directions, led me to suspect that Auerbach's isopurpurine might be nothing but an impure flavopurpurine. As soon, therefore, as I received the "Bulletin of the Chemical Society of Paris," containing Rosenstiehl's paper, I proceeded to apply his method of purification to a quantity of the isopurpurine which I had separated according to Auerbach's method.

By repeated treatment with hot benzole, I removed the alizarine, and, by a solution in alcohol, separated more perfectly than I had done before, the flavopurpurine from the small amount of an-
492 thrapurpurine which was present; and I then found that the product agreed exactly, in every respect, with the description of flavopurpurine given by Schunk and Romer. I will here draw attention to what I consider a misapplication of a word, which may create confusion. Rosenstiehl, like Graebe & Liebermann, has evidently fallen into the mistake of supposing that Auerbach's publications regarding the substance which he called isopurpurine anticipated those of Perkin. This is true as far as the publications in the journal entitled "Montieur Scientifique" are concerned, but in the "Chemical News" and in the "Quarterly Journal of the Chemical Society," of London, I find publications by Perkin on the subject anticipating Auerbach—in one case by two years, and in another by two months. Ignorant of these, Rosenstiehl, like Graebe & Liebermann, gives the credit of first observing an isomeric purpurine in artificial alizarine to Auerbach, and retains his name for the substance, which they recognize to have been first accurately studied by Perkin, but which, as a matter of fact, he was also the first, by fully two years, to observe. It is, therefore, to be remembered that when these authors speak of isopurpurine, they intend to designate the body investigated by Perkin, called by him anthrapurpurine, and which I have always designated by that name.

In addition to the separation of anthrapurpurine by the method which I have described in my previous testimony in this case, I have also separated it from artificial alizarine by the method given by Perkin, and which, according to Rosenstiehl's recent publication, above mentioned, yields a pure product.

Re-d. 220. Please here complete the statement which you began to make in your answer + 103, and which was interrupted by counsel for defendants.

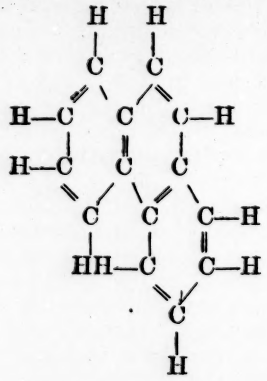
A. When my previous answer was discontinued, I had carried my description of the discovery made by Graebe and Liebermann to the point when Graebe, having prepared other quinones, found also that, by the substitution of two atoms of oxygen, linked to each other, for two atoms of hydrogen in the substance naphthaline, represented, according to the graphical method, in the following manner:



493 they might form a naphthachinone by the substitution of two atoms of oxygen for hydrogen just as before.

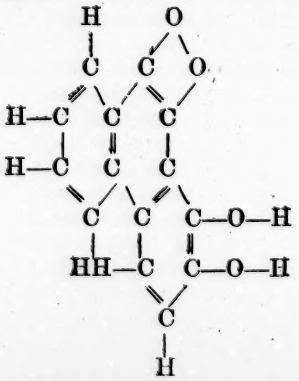
Various derivatives and compounds of this body were found to possess decided colorific properties, but yet were in no respect alizarine.

Analogy, however, suggested to Graebe and Liebermann that alizarine might be a chinone like them, but with another base. To discover this base they heated alizarine with zinc dust, and obtained a body which careful examination showed them was anthracene, a compound which on the same system would be expressed as follows:



—being related to naphthaline just as that was related to benzole.

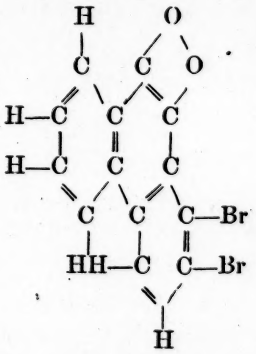
They next recognized in the body called anthracenuse by Laurent the chinone of anthracene. To convert this into alizarine there, however, remained not "to add two more atoms of oxygen" (see Chandler's affidavit in this case), but to "substitute two atoms of hydroxyl OH for two atoms of hydrogen" (see Chandler in Johnson's Encyclopedia); in other words, to convert the substance into what is indicated by this figure—



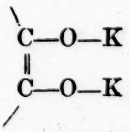
494 Simple as this substitution may appear on paper or as expressed in words, it required many experiments and patient work to effect it in practice.

Thus, though they had succeeded already in the case of benzole and naphthaline compounds in this dismemberment and replacement (this pulling off of hydrogen and hooking on of hydroxyl) without disintegration of the molecules acted upon, it by no means followed that the more complex molecule of anthracene would submit to such treatment without destruction or falling to pieces of its nucleus.

This substitution was accomplished by first introducing bromine in place of the two hydrogen atoms which were to be replaced, and so getting the following compound (which, however, was only obtained by a series of steps, as indicated in the patent)—

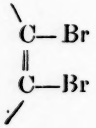


and then, by heating with caustic potash, causing *O K* to replace the bromine thus (I omit all but the modified part of the figure)—

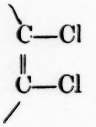


This was the alizarate of potassium, which, on the simple addition of a mineral acid, liberated alizarine.

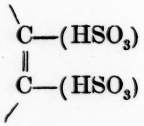
Now, when it had once been proved that this replacement of hydrogen (H) by hydroxyl (OH) could be accomplished without destruction of the molecule and with the production of alizarine, it followed as a matter of course that any of the well known agencies for effecting the same substitution might be employed in place of bromine. Thus, instead of forming bibromanthrachinon (for
495 economy of space I will only represent that part of the molecule which suffered modification)—



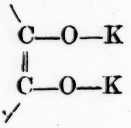
we might employ bichloranthrachinon—



or bisulphanthrachinon—



In each case the added atoms or molecules would simply yield their places on fusion with soda, and the product, potassic alizarate, would result—



By treating this body, in turn, by any strong acid the O—K would be replaced by O—H, and the object of this step of the process would be accomplished, i. e., the substitution of two atoms of hydroxyl OH in place of two atoms of hydrogen. From this explanation of the subject it will, I think, be evident that the discovery made by Graebe and Liebermann was, in fact, the discovery of the true relations existing between anthracene and alizarine, not only in composition but in structure; and that their invention, so far as it related to chemically pure alizarine, consisted in the devising a series of processes whereby the transformation, both in composition and structure, from anthracene to alizarine might be effected. As I have already stated these processes produced other products besides chemically pure alizarine, which are new and useful as dye-stuffs, and thus the
496 product of these processes became a new composition of matter. It also appears that as far as concerns the theoretical considerations on which this discovery and invention are based, it is entirely immaterial which of the substances, bromine, chlorine, or sulphuric acid, is used in effecting the introduction of the hydroxyl,

which constitutes one of the important steps, but that the invention was complete when this change had been effected, and that it was a mere question of convenience or economy as to which should be used.

In view of all this, if I suppose the passage you have quoted from the Vienna report to imply that Graebe and Liebermann had attempted to manufacture artificial alizarine by their patented process, but had failed thus to produce it—had failed also in their attempts to make it by the use of sulphuric acid in place of bromine, and that it was to a subsequent discovery made by Heinrich Caro that the manufacture of artificial alizarine owed its origin—then I should say that this statement was inconsistent with the general history which I have given and with the following specific statements:

In the declaration of H. Caro, "In the matter of the petition of Heinrich Caro, Charles Graebe and Charles Liebermann for letters patent No. 1,936, 1,839, and the opposition of William Henry Perkin thereto," I find as follows:

"3. As the chemist of the said company, it was of importance to consider the best and most economical modes of carrying the said invention into practice, and whilst in Berlin in the month of April last, I had many conversations and discussions with Messrs. Graebe and Liebermann upon that subject; in the course of such conversations the use of sulphuric acid in place of bromine in the carrying out of the said invention was frequently proposed."

"I returned to Mannheim immediately afterwards, and Mr. Graebe shortly after, in the month of May, 1869, came to Mannheim, and we then proceeded to carry out the said invention. We first used the original process, as described in the said specification of the patent No. 3,850, 1868, and afterwards we carried out the same process substituting sulphuric acid for the bromine originally employed."

Also with the declaration made at the same time with the above, in connection with the application for an English patent by Charles Graebe, in which he says:

"I concur in the statements made by him (Caro) at paragraphs 2, 3, and 4 of the said declaration and particularly in his state-
497 ment that the substitution of sulphuric acid for bromine or chlorine in the carrying out of the invention into practice was frequently proposed and discussed at our meetings in Berlin in the month of April, 1869."

* * * *

"After the publication of that paper, the said Charles Liebermann and I proceeded to endeavor to carry out the discovery then announced to practical purposes, and after a lengthened series of experiments and researches we arrived at the practical result we expected, which we then embodied in a specification, and applied for patents in various countries."

Also, in their application for an English patent, June 25th, 1869, in which they say:

"We have now discovered that a similar result" (the production

of alizarine from anthracene) "may be obtained by substituting sulphuric acid for bromine or chlorine in the above process."

In fact, the whole patent is based on a joint discovery made by Caro, Graebe and Liebermann.

Also, in an article published by Graebe and Liebermann, recounting their investigations connected with the production of artificial alizarine, published in the *Annalen der Chemie und Pharmacie*, supplementary vol. 7, March 17, 1870, p. 303, they say as follows:

"Alizarine can also be obtained by converting anthrachinone into anthrachinonebisulpho-acids, as this on fusion with hydrated potash exchanges the two sulphuric acid radicals for hydroxyl. Further details we reserve."

No mention whatever is made of Caro in this connection, but they speak of this process exactly as they do of their own original discovery.

Again, in another volume of the same journal, viz., vol. 160, for 1872, at p. 130, in a further communication by Graebe and Liebermann, they say as follows:

"As we first, in common with Caro, found anthrachinone on heating with sulphuric acid over 200° to be converted into sulpho-acids, which, on melting with hydrate of potash, furnish alizarine."

Adjourned subject to notice.

498 PROFS. GRAEBE AND LIEBERMANN ON ARTIFICIAL ALIZARINE.

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499 ALIZARINE.

On Alizarine and Anthracene.—By C. Gräbe and C. Liebermann.

(From the Berichte der deutschen chemischen Gesellschaft zu Berlin. Berlin, 1868. Erster Jahrgang. Page 49.)

After one of us had proved that chloroxynaphthalic acid was to be considered as a quinone, we considered it probable that alizarine

might also belong to this class of quinones. To be able to test this view experimentally, it was first necessary to explain the constitution of the hydrocarbon which lies at the base of alizarine. We succeeded by the aid of Baeyer's method of reducing arromatic compounds with zinc-dust, in preparing the mother substance of alizarine. By heating alizarine with zinc-dust a hydrocarbon was produced, having the composition $C_{14}\ H_{10}$, and coinciding exactly in its properties with anthracene. We also obtained the characteristic red compound with picric acid. Antracene is the only product in this reaction, and is obtained pure at once.

500 According to our experiments, alizarine, which is hence a derivative of anthracene, must have the formula $C_{14}\ H_8\ O_4$; the older analysis of Schunck and Robiquet, as also the more recent ones of Bolley and Rosa, correspond to this formula better than to the formula $C_{16}\ H_6\ O_3$, heretofore almost universally adopted.

Supported by the similarity of the physical properties of alizarine to those of chloroxynaphthalic acid, and of the oxynaphthoquinone of Martius and Griess, we believe we that we may already venture to give the following rational formula for alizarine:

$$C_{14}\ H_6 \begin{cases} (O\ H)_2 \\ (O_2)'' \end{cases} \text{ alizarine, bioxyanthraquinone.*}$$

Alizarine, consequently, is not isomeric with oxynaphthoquinone,

$$C_{10}\ H_5 \begin{cases} O\ H \\ (O_2)'' \end{cases} \text{ which is derived from naphthaline,}$$

and from which we found naphthaline is produced by means of zinc-dust. We retain for a subsequent communication the report of our experiments, undertaken to establish our view of the constitution of alizarine.

On the Artificial formation of Alizarin.—By G. Gräbe and C. Liebermann.

(From the Berichte der deutschen chemischen Gesellschaft, 1869, vol. ii, p. 14.)

About a year ago we communicated to the Chemical Society the first result of an investigation which we had undertaken in order to elucidate the constitution of alizarin. We found at that time that alizarin is a derivative of anthracene.

The question in regard to the composition of this coloring matter was thereby decided, and we were placed in position to make up a rational formula for the same, on the basis of theoretical considerations.

501 Simultaneously therewith the first step was taken towards the attainment of the artificial production of alizarin. We have now been so fortunate as to solve this second problem. We have produced from anthracene artificial alizarin. The properties of the product obtained by us, as well as the colors which we have

* We call the quinone of anthracen anthraquinone, $C_{14}\ H_8\ (O_2)''$.

produced with the same on mordanted cotton, exhibit perfectly the identity of the artificial alizarin with that obtained from madder-root. We exhibit to the society samples of the sublimed artificial coloring matter, as well as specimens of calico colored with it.

The methods which have led to the above results, and which we shall describe later, confirm the accuracy of the rational formula for alizarin recently advanced by us.

Of what importance our discovery will be for the madder industry, when it becomes practicable to make the same technically applicable, we need not set forth in detail.

The enormous consumption of madder in calico printing, the great tracts of fertile ground which are necessary for its culture, all speak with sufficient clearness of the importance to which a new branch of industry would attain, if it was founded on the artificial production of alizarin from an ingredient of the oil of coal tar.

On Artificial Alizarin.—By C. Grabe and C. Liebermann.

(From the Berichte der deutschen chemischen Gesellschaft, 1869, vol. ii., p. 332.)

Since the contents of our French patent have obtained publicity, we will not longer delay communicating to the chemical society our process of obtaining alizarin from anthracene, and thereby complete our short notice of the 11th of January. In the following we shall give the method in general features only, while we reserve the experimental details and the analyses for a complete essay on anthracene and alizarin, to appear shortly.

Through the reduction of alizarin to anthracene, and the theoretical view that the first is a quinonic acid like chloranilic acid
502 and chlornaphthalic acid, the task of making artificial alizarin had received quite a determined form, and could be looked at with greater expectation of success than formerly, as a glance at the following formulæ shows:

$C_{14}H_{10}$ — Anthracene.

$C_{14}H_6\left\{\begin{matrix}(O_2)''\\(OH)_2\end{matrix}\right.$ — Alizarin.

The question was to indroduce in the anthracene, in place of two hydrogen atoms, the group $(O_2)''$, characteristic of quinone, and again replace two other atoms of hydrogen by two atoms of hydroxyl.

Anderson has, by oxidation with nitric acid, obtained from anthracene a compound called by him oxanthracene, which, after our view, as already earlier communicated, is to be regarded as the quinone of anthracene (anthraquinone), $C_{14}H_8(O_2)''$. This same anthraquinone is produced by other means of oxidation, such as by chromate of potash and sulphuric acid or acetic acid.

We now endeavored to introduce into this anthraquinone two atoms of chlorine or bromine, in order in this way to secure both the hydroxyl groups still missing.

Chlorine acts on anthraquinone very slowly and with difficulty, but by means of bromine the substitution is successful on heating to

100°. If we heat anthraquinone with four atoms of bromine in a tube, closed by fusion, for several hours in a water-bath, it becomes altered into bibromanthraquinone, while at the same time hydrobromic acid is set free and escapes by opening the tube.

$$C_{14}H_8(O_2)'' + 4Br = C_{14}H_6Br_2(O_2)'' + 2BrH.$$

The bibromanthraquinone, which will be obtained in bright yellow needles by recrystallization from benzol, or by sublimation, distinguishes itself by its permanency.

On being heated with very strong potash solution, a reaction commences first at about 170°, whereby the mass takes on a dark-blue color. It then dissolves in water, forming the well-known violet color of alizarate of potash. On adding an acid to this solution the alizarin will be precipitated in red-brown flocks.

502½ The following equation will show the formation of the potash salt of alizarin from bibromanthraquinone:

$$C_{14}H_6Br_2(O_2)'' + 4KHO = C_{14}H_6(OK)_2(O_2)'' + 2KBr + 2H_2O.$$

After we had succeeded, according to the above-described method, of making bibromanthraquinone and converting it into alizarin, we found still a second way for obtaining the former.

As we have already communicated, bibromanthracene, on being heated with nitric acid, becomes changed into anthraquinone, according to the following equation:

$$C_{14}H_8Br_2 + 2NHO_3 = C_{14}H_8(O_2)'' + 2Br + 2NHO_2.$$

We supposed, therefore, that we could get in the same way bibromanthraquinone from tetrabromanthracene. The compound described by Anderson as $C_{14}H_8Br_4$ must be regarded as tetrabromanthracene, $C_{14}H_6Br_4$, as our analyses decidedly show. We obtained the same in an indirect way from anthracene when we at first, according to Anderson's statement, allowed bromine in the form of vapor to act on anthracene in the cold till no more bromine was absorbed. There is formed by this, bibromanthracenetetrabromide, $C_{14}H_8Br_2Br_4$, and not anthracene hexabromide, $C_{14}H_{10}Br_6$, as Anderson supposed; thus:

$$C_{14}H_{10} + 8Br = C_{14}H_8Br_2, Br_4 + 2BrH.$$

This compound which arises through simultaneous substitution and addition, becomes, by alcoholic potash solution, reconverted to the anthracene type, while tetrabromanthracene is formed.

$$C_{14}H_6Br_2Br_4 + KHO = C_{14}H_8Br_4 + 2KBr + 2H_2O.$$

By oxidation with nitric acid, this tetrabromanthracene becomes, as we supposed, changed into bibromanthraquinone, which, like that obtained from anthraquinone, is converted into alizarin by heating with potash.

$$C_{14}H_6Br_4 + 2NHO_3 = C_{14}H_6Br_2(O_2)'' + Br_2 + NHO_2.$$

503 We have also performed the same reactions with chlorine, by allowing the latter to act on anthracene at 150°, and treating the compound formed with alcoholic potash, we

obtained thus tetrachloranthracene, from which, with nitric acid, at first bichloranthraquinone was formed, and then on heating this with potash alizarin was obtained. But, in general, the reactions with chlorine were less successful than those with bromine.

In our first notice we have already hinted that we have detected no difference between the natural and artificial alizarin, and that the very characteristic colors which both possess when fixed on cotton mordanted with alumina and iron are perfectly identical. We believe, therefore, that it is with one and the same chemical individual that we have to deal, and not with isomerous compounds, of which an extraordinarily great number is conceivable, and of which an example already exists, as we have hinted, in chrysophanic acid.

In conclusion, we will call attention to the fact that our production of alizarin is the first example of the artificial formation of a coloring matter occurring in plants.

Coloring Matters.—Sealed the 15th June, 1869, and dated the 18th December, 1868.

Letters patent to Charles Liebermann and Charles Graebe, of Berlin, for the invention of "improvements in preparing coloring matters."

English patent, A. D. 1868, 18th December, No. 3850.

Provisional specification left by the said Charles Liebermann and Charles Graebe, at the office of the Commissioners of Patents, with their petition, on the 18th December, 1868.

We, Charles Liebermann and Charles Graebe, of Berlin, in the kingdom of Prussia, chemists, do hereby declare the nature
504 of the said invention for "improvements in preparing coloring matters" to be as follows:

This invention has for its object improvements in preparing coloring matters for dyeing and printing, and for this purpose we take the substance known by the name anthracene or paranapthalin, which is formed under the high boiling portions of coal tar, and is prepared and purified by distillation and crystallization. From this substance can be obtained by nitric acid, as is well known to chemists, a compound of the formula $C_{14}H_8O_2$(C = 12, O = 16), which is called oxanthracene or anthrachinon.

We prepare the anthrachinon by the following new methods:

(1.) Anthracene is treated by bichromate of potassium and sulphuric acid or acetic acid at the temperature of boiling water or higher, or instead of chromate of potassium any other salt of chromic acid can be employed.

(2.) Anthracene is entirely, or for the greatest part, dissolved in acetic acid heated at 100° to 120° C., and is converted into anthrachinon by the addition of the necessary quantity of nitric acid.

We mix the anthrachinon thus obtained with bromine by pressure

in the proportion of one equivalent of anthracene to four equivalents of bromine, and heat it to 80–130° C. in a closed vessel. Great quantities of hydrobromic acid are produced, which can be collected by leading it into water or an alkaline solution, our new substance of the formula C_{14} H_6 Br_2 O_2 (bibromanthrachinon) remaining in the vessel in a solid state. The bibromanthrachinon $C_{14}H_6Br_2O_2$ can also be prepared in the following way: Bromine acting on anthracene at the temperature of the air forms a crystalline mass, which treated with a solution of caustic potass in alcohol gives a substance of the formula $C_{14}H_6Br_4$ (tetrabromanthracene), which is changed by oxidating agents into bibromanthrachinon, $C_{14}H_6Br_2O_2$; or instead of bromine chlorine can be employed in the same manner for the production of bichloranthrachinon. On treating the bibromanthrachinon or bichloranthrachinon with a concentrated solution of caustic potass
505 or soda to 180–260° C. a blue color is produced by the formation of the potassium or sodium salt of alizarine. The alkaline mass thus obtained is extracted by water, and from the violet solution yellow flocks of alizarine are precipitated by an organic or inorganic acid. The alizarine prepared in this artificial way is perfectly pure, and can be employed in all the applications to which the different preparations of madder are used.

Patent.

Specification in pursuance of the conditions of the letters patent filed by the said Charles Liebermann and Charles Graebe, in the Great Seal Patent Office, on the 17th June, 1869.

To all to whom these presents shall come, we, Charles Liebermann and Charles Graebe, of Berlin, in the Kingdom of Prussia, chemists, send greeting.

Whereas, Her Most Excellent Majesty, Queen Victoria, by her letters patent bearing date the eighteenth day of December, in the year of our Lord one thousand eight hundred and sixty-eight, in the thirty-second year of her reign, did, for herself, her heirs and successors, give and grant unto us, the said Charles Liebermann and Charles Graebe, her special license that we, the said Charles Liebermann and Charles Graebe, our executors, administrators, and assigns, or such others as we, the said Charles Liebermann and Charles Graebe, our executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "Improvements in Preparing Coloring Matters," upon the condition (amongst others) that we, the said Charles Liebermann and Charles Graebe, our executors or administrators, by an instrument in writing under our, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said invention, and
506 in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six

calendar months next and immediately after the date of the said letters patent.

Now know ye that we, the said Charles Liebermann and Charles Graebe, do hereby declare the nature of our said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, that is to say:

The following is the manner in which we prefer to proceed for preparing the anthrakinon or oxanthracene: We take 1 part of anthracene, $2\frac{1}{2}$ parts by weight of bichromate of potassium, and from 10 to 15 parts of concentrated acetic acid, and heat these substances together in a vessel, either of glass or clay, to from 100° to 120° C. until nearly all the bichromate of potassium is dissolved and the liquid has acquired a deep green color. We then recover the acetic acid not consumed in the reaction by distillation, and treat the residue with water to remove the chromic acetate. From the insoluble mass we obtain the anthrakinon in a pure state by distilling the whole in a retort of glass or iron. In the place of the acetic acid may be used sulphuric acid diluted with 1 or 2 parts of water, and in the place of the bichromate of potassium any other chromate or chromic acid may be employed.

Instead of the method just described we, in some cases, employ the following: We heat anthracene in a vessel of glass or clay with 10 parts of concentrated acetic acid to 100° C. or more, and we add nitric acid of 1.3 spec. gr. in small portions till the violent reaction ceases. After distillation of the acetic acid we purify the residue as before. We then convert the anthrakinon prepared by one of the methods above described into bibromanthrakinon. For this purpose we take 3 parts of anthrakinon and 5 parts of bromine, and we heat these substances to a temperature by preference of 100° C. for ten or twelve hours, or until nearly the whole of the bromine has disappeared, in a suitable closed vessel, either of glass or glazed iron, which is capable of sustaining the pressure generated by the reaction.

The apparatus is then allowed to cool; it is opened in order
507 to permit the escape of hydrobromic acid, which can be recovered by absorption either in water or in an alkaline solution. We purify the bibromanthrakinon remaining in the vessel as a solid substance by crystallization from benzol.

Instead of the method before described for preparing the bibromanthrakinon we also employ the following: We convert first the anthracene into a bromine forming the tetrabromanthracene, known to chemists by the investigations of Anderson. We take one part of this tetrabromanthracene and heat it in a retort of glass or clay with about 5 parts of nitric acid of 1.3 spec. gr. to 100° C., as long as vapors of bromine are evolved. We distill the greater portion of the nitric acid, wash the residue with water, and purify it by crystallization from benzol We thus receive the bibromanthrakinon as before in the form of a yellow solid mass. We then convert the bibromanthrakinon into alizarine. For this purpose we take 1 part of

bibromanthrakinon, from 2 to 3 parts of caustic potash or soda, and as much water as is necessary to dissolve the alkali, and heat the whole in an open vessel of glass, glazed iron, or silver to from 180° to 260° C. for one hour, or till the mass has acquired a deep blue color. We then dissolve it in water and filter the violet solution, from which we precipitate the alizarine by an inorganic or organic acid. We collect the yellow flocks of alizarine thus obtained on a filter and was them with water. By these methods we receive the alizarine in a form in which it can be employed in the same manner as the different preparations from madder.

In the place of bromine, chlorine may be employed, but not so conveniently, since the reactions above described are more difficult to accomplish with chlorine than with bromine.

Having thus described the nature and particulars of our said invention, and the manner of performing the same, we would have it understood that we do not confine ourselves to the exact details of the process hereinbefore given; but what we claim is, the artificial production of alizarine by first preparing bibromanthrakinon
508 or bichloranthrakinon, and then converting these substances into alizarine, as herein described.

In witness whereof, we, the said Charles Graebe and Charles Liebermann, have hereunto set our hands and seals this second day of June, in the year of our Lord 1869.

CHARLES GRAEBE. [L. S.]
CHARLES LIEBERMANN. [L. S.]

We hereby certify the above to be a true copy.

SAMUEL CASSERLEY,
JAMES CHARLES KANE,
Clerks in the Patent Office.

United States Patent Office.

Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia.—Letters Patent No. 95,465, dated Oct. 5, 1869.

Improved Process of Preparing Alizarine.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that we, Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, in the kingdom of Prussia, have invented a process for preparing alizarine from anthracene; and we do hereby declare the following to be a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same.

We first change the anthracene into anthrakinon (oxan-
509 thracene,) a substance known to chemists by the investigations of Anderson.

For this purpose we take one part, by weight, of anthracene, two and a half parts, by weight, of bichromate of potassa, and ten or fifteen parts, by weight, of concentrated acetic acid, and we heat these substances together in a vessel, either of glass or clay, to about 100° centigrade to 120° centigrade, till nearly all of the bichromate of the potassa is dissolved and the liquid has acquired a deep green color.

We then recover the acetic acid not consumed in the reaction by distillation, and treat the residuum with water to remove the chromic acetate. From the insoluble mass we obtain the anthrakinon in a pure state by distilling the whole from a retort of glass or iron.

In the place of the acetic acid, sulphuric acid, diluted with one or two parts of water, may be employed.

Instead of the method just described we also employ the following one:

We heat the anthracene in a vessel of glass or of clay, with ten parts of concentrated acetic acid, to about 100° centigrade, or a little higher, and we add nitric acid, of about 1.3 specific gravity, in small portions, till the violent reaction ceases. After distillation of the acetic acid, we purify the residuum as before.

We then convert the anthrakinon, prepared by one of the methods described, into bibromanthrakinon.

For this purpose we take three parts of anthrakinon, five parts of bromine, and we heat these substances for ten or twelve hours, or until nearly the whole of the bromine has disappeared, to a temperature, by preference, of about 100° centigrade, in a suitable close vessel, either of glass or enamelled or glazed iron, which is capable of sustaining the pressure generated by the reaction.

The apparatus is then allowed to cool. It is opened in order to permit the escape of hydrobromic acid, which can be recovered by absorption either in water or in an alkaline solution.

We purify the bibromanthrakinon remaining in the vessel, as a solid substance, by crystallization from benzole.

510 Instead of the method above described for preparing bibromanthrakinon, we also employ the following:

We convert first the anthracene into a bromine derivative, into the tetrabromanthracene, known to chemists by the investigations of Anderson.

We take one part of this tetrabromanthracene, and we heat it in a retort of glass or clay with about five parts of nitric acid of about 1.3 specific gravity to 100° centigrade, as long as vapors of bromine are evolved.

We distill off the greater portion of the nitric acid, wash the residuum with water, and purify it by crystallization from benzole.

We thus receive the bibromanthrakinon as before, in the form of a yellow, solid mass.

We then convert the bibromanthrakinon into alizarine. For this purpose we take one part of bibromanthrakinon, two to three parts of caustic potash or soda, and so much water as is necessary to dissolve the alkali, and we heat the whole in an open vessel of glass, glazed or enameled iron, or silver, to about 180° to 260° centigrade for one hour, or until the mass has acquired a deep blue color.

We then dissolve it in water and filter the violet solution, from which we precipitate the alizarine by an inorganic or organic acid.

We collect the yellow flocks of alizarine thus obtained on a filter and wash them with water. By these methods we receive the alizarine in a form in which it can be employed in the same manner as the different preparations from madder.

In the place of bromine chlorine may also be employed, but not so conveniently, as the reactions above described are more difficult to accomplish with chlorine than with bromine.

Having thus described the nature of our invention and the manner of performing and carrying out the same, we would have it understood that we do not confine ourselves to the exact details hereinbefore given; but

What we claim is—

511 The within-described process for the production of alizarine, by first preparing bibromanthrakinon or bichloranthrakinon and then converting these substances into alizarine, substantially as above set forth.

CHARLES GRAEBE.
CHARLES LIEBERMANN.

Witnesses:
J. F. PRILLWITZ.
N. GOTTLEIB.

ENGLISH LETTERS PATENT to Heinrich Caro, Charles Graebe, and Charles Liebermann for the Invention of "Improvements in Preparing Coloring Matters," A. D. 1869, 25th June, No. 1936.

Preparing Coloring Matters.

Sealed the 11th January, 1870, in pursuance of an order of the Lord Chancellor, and dated the 25th June, 1869.

Provisional Specification left by the said Heinrich Caro, Charles Graebe, and Charles Liebermann at the office of the Commissioners of Patents, with their Petition, on the 25th June, 1869.

We, Heinrich Caro, of Mannheim, Grand Duchy of Bade, chemist; Charles Graebe, of Berlin, Kingdom of Prussia, chemist, and Charles Liebermann, of Berlin, chemist, do hereby declare the nature of the said invention for "Improvements in Preparing Coloring Materials" to be as follows:

This invention relates to improvements on an invention for which letters patent were granted to Charles Liebermann and Charles Graebe

for "Improvements in Preparing Coloring Matters," dated the
512 18th day of December, 1868, No. 3850, in which the preparation of artificial alizarine is based upon the action of caustic alkalies upon bibromanthrakinon or bichloranthrakinon. We have now discovered that a similar result may be obtained by substituting sulphuric acid for bromine or chlorine in the above process. We thus obtain the sulpho-acids of anthrakinon, which, by being dissolved in and heated with an excess of caustic alkali, are converted into alizarine.

Specification filed in pursuance of the conditions of the letters patent, and of an order of the Lord Chancellor, by the said Heinrich Caro, Charles Graebe, and Charles Liebermann, in the great seal patent office, on the 13th January, 1870.

To all to whom these presents shall come:

We, Heinrich Caro, of Mannheim, Grand Duchy of Bade, chemist, Charles Graebe, of Berlin, in the Kingdom of Prussia, chemist, and Charles Liebermann, of Berlin, chemist, send greeting.

Whereas, her most excellent majesty, Queen Victoria, by her letters patent, bearing date the twenty-fifth day of June, in the year of Lord one thousand eight hundred and sixty-nine, in the thirty-third year of her reign, did, for herself, her heirs and successors, give and grant unto us, the said Heinrich Caro, Charles Graebe, and Charles Liebermann, her special license that we, the said Heinrich Caro, Charles Graebe, and Charles Liebermann, our executors, administrators, and assigns, or such others as we, the said Heinrich Caro, Charles Graebe, and Charles Liebermann, our executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "improvements in preparing coloring matters," upon the condition (amongst
513 others) that we, the said Heinrich Caro, Charles Graebe, and Charles Liebermann, our executors or administrators, by an instrument in writing under our hands and seals, or under the hand and seal of one of us, should particularly describe and ascertain the nature of the said invention, and in what manner the same was to be performed, and caused the same to be filed in the great seal patent office on or before the thirteenth day of January, one thousand eight hundred and seventy.

Now know ye, that we, the said Heinrich Caro, Charles Graebe, and Charles Liebermann, do hereby declare the nature of our said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, that is to say:

This invention relates to improvements on an invention granted to Charles Liebermann and Charles Graebe for improvements in pre-

paring coloring matters, dated the eighteenth day of November, one thousand eight hundred and sixty-eight, No. 3850, in which the preparation of artificial alizarine is based upon the action of caustic alkalies upon bibromanthrakinon or bichloranthrakinon. We have now discovered that a similar result may be obtained by substituting sulphuric acid for bromine or chlorine in the above process. We thus obtain the sulpho-acids of anthrakinon, which by being dissolved in and heated with an excess of caustic alkali are converted into alizarine.

This invention relates to improvements in the production of coloring matters, and more especially to improvements in the method of producing what is known as artificial alizarine from anthracene, a method of producing which was described in letters patent granted to Charles Liebermann and Charles Graebe, dated eighteenth December, one thousand eight hundred and sixty-eight, and consisted in the production of artificial alizarine by converting anthracene into either bibromanthrakinon or bichloranthrakinon, and then acting upon the same by means of an alkali and precipitating the alizarine contained in the alkaline solution by means of an acid.

In the complete specification of the aforesaid letters patent granted to Charles Liebermann and Charles Graebe two different
514 series of processes are described for obtaining the brominated or chlorinated derivatives of anthrakinon.

In the first of these processes the anthracene is submitted to the action of oxidizing agents, as is well understood, and the oxidized anthracene or anthrakinon is then treated with bromine or chlorine.

In the second of these processes the anthracene is first treated with bromine or chlorine, and subsequently submitted to an oxidizing process in order that the desired compounds, videlicet, bibrom or bichlor anthrakinon may be obtained.

In an analogous manner we now employ sulphuric acid as a substitute for the bromine or chlorine employed in the processes above referred to, and we thus obtain the sulphuric acid derivatives of anthrakinon, which we call the sulpho acids of anthrakinon.

Our invention is carried into effect by means of either of the two processes, which we will proceed to describe.

In the one process we proceed as follows: We take about one part by weight of anthrakinon and about three parts by weight of sulphuric acid of about the specific gravity of 1.848, and introduce the same into a retort, which may be made of glass, or of porcelain, or of other material not easily acted upon by sulphuric acid, and the contents are then to be heated up to about two hundred and sixty degrees Centigrade, and the temperature is maintained until the mixture is found no longer to contain any appreciable quantity of unaltered anthrakinon. The completion of this desired operation may be ascertained or tested by withdrawing a small portion of the product from time to time, and continuing the operation at the high temperature until such product, upon being diluted with water, is found to form a substantially perfect solution, thereby indicating that

the anthrakinon has become either entirely or in greater part converted into the desired product. The results of this operation are then allowed to cool and are diluted with water; we then add carbonate of lime in order to neutralize and remove the excess of sulphuric acid contained in the solution; the mixture is then
515 filtered, and to the filtrate carbonate of potash or carbonate of soda, by preference in solution, is to be added until carbonate of lime is no longer precipitated; the mixture is then filtered and the clear solution is evaporated to dryness, by which means the potash or soda salts of what we call the sulpho acids of anthrakinon are obtained, and which are to be treated in the following manner: We take about one part by weight of this product, and from two to three parts by weight of solid caustic soda or potash; water may be added or not, but by preference we add as much water as is necessary to dissolve the alkali after admixture; we heat the whole in a suitable vessel, and the heating operation is continued at a temperature of from about one hundred and eighty degrees to about two hundred and sixty degrees Centigrade for about one hour, or until a portion of the mixture is found, upon withdrawing and testing it, to give a solution in water, which being acidulated with an acid, for example, sulphuric acid, will give a copious precipitate of the coloring matters. The heating operation having been found to have been continued for a sufficient time, the resulting products are then dissolved in water, and we either filter or decant the solution of the same, from which we precipitate the coloring matters or artificial alizarine by means of a mineral or organic acid, such, for example, as sulphuric or acetic acid. The precipitated coloring matters thus obtained are collected in a filter or otherwise, and after having been washed may be employed for the purposes of dyeing and printing, either in the same way as preparations of madder are now used or otherwise.

In carrying out other process, we proceed as follows: We take about one part by weight of anthracene and about four parts by weight of sulphuric acid of specific gravity of about 1.848, and the mixture, being contained in a suitable vessel, is heated to a temperature of about one hundred degrees Centigrade, at which temperature it is to be maintained for the space of about three hours; the temperature is then to be raised to about one hundred and fifty degrees Centigrade, which temperature is to be maintained for about one hour, or until a small portion of the product, when
516 submitted to the subsequent processes hereinafter described, is found to produce the desired coloring matters; we then allow the result obtained by this operation to cool, and dilute it with water, by preference in the proportion of about three times its weight. To the solution thus obtained we add, for every part of anthracene by weight which had been employed in the previous operation, about from two to three parts by weight of peroxide of manganese, preferring to employ an excess, and we boil the whole strongly for some time, and in order fully to insure the desired

degree of oxidation, the mixture may be subsequently concentrated, and by preference be evaporated to dryness and the heat be continued until a small portion of the oxidized product, when submited to the subsequent processes hereinafter described, will produce the desired coloring matters. We then neutralize and remove the sulphuric acid contained in this mixture, and at the same time precipitate any oxides of manganese which may be held in solution by adding an excess of caustic line, which we use by preference in the form of milk of lime, and we add the same until the mixture has an alkaline reaction. We then filter and add to the filtrate carbonate of potash or soda until there is no further precipitation of carbonate of lime. The solution is then filtered and evaporated to dryness, and we thus obtain the potash or soda salts of what we call the sulpho-acids of anthrakinon.

In effecting the conversion of the oxidized products thus obtained into coloring matters, or into what we *we* call artificial alizarine, we proceed as follows: We take one part by weight of this product, and from two to three parts, by weight, of solid caustic soda or potash, and water may be added or not, but by preference we add as much water as is necessary to dissolve the alkali. After admixture we heat the whole in a suitable vessel, and continue the heating operation, at a temperature from about one hundred and eighty degrees to about two hundred and sixty degrees Centigrade, for about one hour or until a portion of the mixture is found to give solution in water, which upon acidulation with an acid, for
517 example, sulphuric acid, is found to give a copious precipitate of the coloring matters. The heating operation having been found to have been continued for a sufficient time, then dissolve the product in water, and either filter or decant the solution of the same, from which we precipitate the coloring matters or artificial alizarine by means of a mineral or organic acid, such, for example, as sulphuric or acetic acid. The precipitated coloring matters thus obtained are collected on a filter or otherwise, and after having been washed may be employed for the purposes of dyeing and printing, either in the same way as preparations of madder are now used or otherwise. Instead of acting upon anthracene by means of sulphuric acid of the density before mentioned, fuming sulphuric acid may be employed, but we prefer to use the ordinary acid, as before described.

In order to effect the process of oxidation before referred to, other oxidizing agents may be used in place of the peroxide of manganese before mentioned, such, for example, as peroxide of lead, or chromic, nitric, or other acids, capable of effecting the desired oxidation, may be employed. If the oxidizing agent be a soluble one, such, for instance, as chromic acid, any excess of the oxidizing agent that may have been employed should be removed or reduced before proceeding with the subsequent operation. Thus, for example, had chromic acid been used in excess, sulphurous acid may be passed through the product before adding the lime. In the case

of the employment of nitric acid, the oxidized mixture should be heated until the greater proportion of the nitric acid has been evaporated, and until the sulphuric acid has become so concentrated that it commences to volatilize.

Although we have mentioned the employment of carbonate of lime and of caustic lime for the purpose of effecting the neutralization of the sulphuric acid existing in the solution of the products obtained from the treatment of anthrakinon and from anthracene, as hereinbefore described, it will be understood that other bases which will neutralize the acid, and which will not in any way be injurious in any of the subsequent processes, may be substituted for the same.

518 Having now described our invention and methods we employ in carrying it into effect, we claim—

Firstly. The manufacture of coloring matters by submitting anthrakinon to the action of sulphuric acid, so as to obtain soluble compounds, which we have called sulpho-acids of anthrakinon, treating the product of such operation with an alkali and precipitating the coloring matters therefrom by means of an acid, as herein described.

Secondly. The manufacture of coloring matters by submitting anthracene to the action of sulphuric acid, oxidizing the product thereby obtained, heating such oxidized product with an alkali, and subsequently precipitating the coloring matters therefrom by means of an acid, as herein described.

In witness whereof I, the said Heinrich Caro, on behalf of myself and said Charles Graebe and Charles Liebermann, have to this, my specification, set my hand and seal this twenty-first day of December, one thousand eight hundred and sixty-nine.

HEINRICH CARO. [L. S.]

Alizarine.—By C. Gräbe, of Konigsberg.

(From "*News Handwörterbuch der Chemie*, vol. i, No. 3, p. 235. Braunschweig, 1871.)

ALIZARINE,* lizaric acid, madder red, matiére colorante rouge: first prepared from madder by Robiquet & Colin, (1826;) artificially by Gräbe & Liebermann, (1868,) from anthracene. Formula: $C_{14}H_8O_4$, is derived from anthracene, and is to be considered as byoxyanthrachinon, $C_{14}H_6(O_2)''(OH)_8$.

Alizarine does not occur free in the fresh madder root,

519 but as a glucoside (Rubian of Schunk, Ruberythric acid of Rochleder,) which, by fermentation or acids, is broken up into alizarine and sugar. In old madder root this change has taken place, to a large extent, by the action of a ferment contained in it.

For the preparation of alizarine from madder many recipes are given. The most practicable is that of E. Kopp. The freshly reaped and coarsely ground madder root is exhausted, first with cold and

*The references to authorities in the original are omitted in the translation.

then repeatedly with warm water containing sulphurous acid, whereby the temperature is regularly raised. The sulphurous acid has the effect of preventing the action of the ferment contained in the madder on the glucosides. On extraction these go into solution, and for the greater part into the warm extract. The latter are mixed with 3½ per cent. to 4 per cent. of sulphuric acid, and heated to 35° or 40°. The glucoside of the purpurine is decomposed at this temperature, and the purpurine separates in consequence of this, while the glucoside of the alizarine remains in solution. This is filtered or decanted and then heated to boiling for several hours, whereby the so-called green alizarine, a mixture of alizarine with a green organic substance, separates. The precipitate obtained, in order to remove a yellow coloring matter, is first washed with water containing hydrochloric acid, then with pure water, and dried at 70°. From this the alizarine is extracted either by solvents having a low boiling point—as wood-spirit, alcohol, or hydrocarbons boiling below 100°—or what, according to E. Kopp, is to be preferred in most cases, with shale oils or other hydrocarbons having their boiling point between 150° and 179°. In the first case an extracting apparatus with uninterrupted circulation of the solvent is employed; the alizarine then separates in the boiling vessels as brownish yellow crusts, which, after being washed with water and dried at a moderate temperature, come into commerce as a powder like alizarine extract. By employing the high boiling oils the vapors of the same are permitted to pass into a cooling cylinder filled with green alizarine, and the dissolved alizarine is extracted from the condensed hydrocarbon by agitation with a dilute solution
520 of caustic soda. The yellow or brownish yellow alizarine which is precipitated from the alkaline solution by an acid is well washed, and then forms the dough-like alizarine extract. The above-mentioned first cold extract of the madder root (the saccharine wash-water), after separating the purpurine, is allowed to ferment for the production of alcohol, and then treated for green alizarine. The exhausted madder roots are treated with sodium carbonate, in order to utilize the coloring matter still contained in them, and the solution is precipitated by the mother liquors from the green alizarine. By this the so-called pectin extract is obtained (see Krapp.)

From anthracene the alizarine can be obtained by fusing the chlorine and bromine derivatives, also the sulpho-acids of anthrachinon. The latter are best adapted for this purpose. The anthracene is first converted by oxidation into anthrachinon, and this, by the action of sulphuric acid, into anthrachinon bisulpho-acid (see anthracene.) The soda salt of the sulpho-acid is heated with two or three times its weight of caustic potash or soda to about 200°, until the first-formed beautiful blue color is changed into a dark violet, and a sample on addition of acid gives a heavy precipitate of alizarine. The whole mass is then mixed with acid, and the separated yellow or brownish

yellow alizarine is well washed. It comes into commerce as a dough or powder, the same as that obtained from madder.

Chemically pure alizarine is obtained by sublimation of the pure madder extract obtained by the method of E. Kopp, or of the artificial alizarine. It is most convenient to bring small quantities into a porcelain crucible having 50 grms. capacity, to cover this with a piece of filter-paper, and then with its cover, and to heat its bottom on a sand-bath to 250°. The commercial products may also be purified by recrystallization from alcohol.

Sublimed, the alizarine forms long and narrow shiny prisms, which, according to their thickness, have a red or reddish yellow color. It crystallizes in similar prisms from hot alcohol or water solution.

From dilute alcohol and watery ether sometimes small scales
521 separate, which are similar to mosaic gold, and contain 3 mol. of water, which goes off at 100°, whereby the crystals become red. Alizarine melts at 215°, sublimes at the same temperature; it begins to vaporize in a current of air or steam at 100°. It is decomposed at about 300°, with carbonization.

Cold water dissolves only insignificant quantities, but from 150° the solubility rapidly increases. One hundred parts of water dissolve at 100° C. 0.034 parts; at 150°, 0.035 parts; at 200°, 0.82 parts; at 225°, 1.70 parts; and at 250°, 3.16 parts. Alcohol, ether, wood spirit, benzol, petroleum, glycerine, and glacial acetic acid dissolve it abundantly, particularly when heated. The solutions have a yellow color, and show no characteristic absoprtion spectrum. A boiling solution of alum takes up a small amount, which again separates on cooling.

Oxidizing agents like boiling nitric acid, ferric chloride, etc., convert alizarine into phthalic acid. By heating with zinc-dust, anthracene is obtained. Nascent hydrogen decolorizes the alcoholic and alkaline solutions, and there is formed the not yet further examined hydralizarin or tetraoxianthracene, $C^{14}H^{6}(OH^{4})$. By cold, fuming nitric acid the alizarine is first dissolved, then after a short time there separates a yellow crystalline, readily changeable nitro-body, which dissolves in boiling water, but on continued boiling is changed into nitro-oxyalizarine, $C^{14}H^{7}(NO^{2})O^{5}$, with the development of nitric oxide. This may be readily purified by re-crystallizing from alcohol and ether, dissolves in potassic hydrate and boiling solution of alum, with a currant-red color. From the alcoholic solution alcoholic potash precipitates, in dark brownish-red flocks, the salt $C^{14}H^{5}K^{2}(N^{2})O^{5}$.

By passing chlorine through water in which alizarine is suspended, the same does not change apparently, but, after removing the excess of chlorine, it dissolves in potash, with a bright red color similar to that of purpurine.

If bromine water is added to a hot saturated alcoholic solution of alizarine, mixed with six or eight parts of water, a light yellow precipitate is formed, while from the filtrate, after driving off the
522 alcohol, orange-yellow needles separate, which approximately agree with the formula of brom. alizarine, $C_{14}H_5BrO_4$. It is

insoluble in water, soluble in alcohol, ether, and bisulphide of carbon, and separates on evaporation of the latter in dark brown lumps. With soda it becomes purplish red; with alumina mordant it gives a brownish red dye, and shows an absorption spectrum which completely resembles that of alizarine.

Sulphuric acid dissolves alizarine unchanged in the cold, and only attacks it with difficulty when heated. Fuming sulphuric acid on heating converts it into a sulpho-acid, the salts of which show solubilities similar to those of sulphuric acid. The acid can be obtained from the lead salt by decomposing with hydrosulphuric acid. It is soluble in all proportions in water; caustic potash dissolves it with a cherry-red color; baryta and acetate of lead give a reddish violet, and alumina salts an orange-red precipitate. By fusing with potassic hydrate, alizarine is again formed.

A solution of alizarine in ammonia furnishes, after standing for weeks or heating for a few hours to 100°, on addition of an acid violet, flocks of alizarinamid (alizarëin), which, when dry, is almost black and dissolves abundantly in water, and readily in alcohol, which it colors violet-red. On evaporating an alcoholic solution it separates as a crystalline powder. Its composition has not been determined with certainty. According to Wolf and Strecker, by the fermentation of the madder, alizarine is converted into purpurine; this is disputed by Schunck.

Salts and Ethers of Alizarine.—Toward bases alizarine acts as a weak acid. The salts like the ethers correspond to the general formula $C_{14} H_6 (O_2) (O Me)_2$. The alkali salts and the ammonium salt dissolve readily in water and alcohol with a beautiful violet color (distinction from purpurine, which gives red solutions); they are little soluble in concentrated caustic potash and salt solutions, and insoluble in ether. Their aqueous and alcohol solution show a characteristic absorption spectrum, with a dark line in the yellow, a narrower one between red and orange, and a difficultly visible one at E 523 (Stokes); diagram also by Perkin. The alkaline earths and the metals give salts insoluble in water, which are colored violet, red, rose, or black. They are obtained by direct combination of alizarine with the base, or by precipitating of the ammonium salt with metallic salts. Alumina salts furnish rose or red, oxide of iron violet or black precipitates. In calico printing these salts are permitted to form on the fibre itself, of cotton mordanted with alumina or oxide of iron. The colors so obtained are very fast towards light, and resist the action of boiling soap.

Barium Salts.—The purple-red precipitate formed by barium chloride and alizareate of ammonium, dried at 100°, has the composition $C^{14} H^6 O^4 Ba + H^2 O$. Wolf and Strecker have examined two more compounds, of which one contains more barium, the other corresponds approximately to the formula $(C^{14} H^7 O^4)^2 Ba + 2 H^2 O$.

Calcium salt, $C^{14} H^6 O^4 Ca + H^2 O$ (dried at 100°), is formed as a purple precipitate by precipitating the ammonium salt by calcium chloride.

Lead salt, $C^{14}H^6O^4Pb$, a purple red compound obtained from lead acetate and ammonium alizarate.

Ethylic ether, $C^{14}H^6O^4(C^2H^5)^2$, is formed by heating ethyliodide with sodium alizarate to 120°, has a light yellow color, is soluble in alcohol, but not in water.

Benzoic-acid ether, $C^{14}H^6(O^2)(O\,C^7H^5O)^2$.—Chlor benzoyl acts on alizarine at 190°, and forms the yellow benzoic-acid ether which is insoluble in water, and which can be obtained in crystals from alcohol, in which it is soluble.

GR.

524 ## ARTIFICIAL ALIZARIN.

By Prof. C. GRAEBE and Prof. C. LIEBERMANN,
In Konigsberg. In Berlin.

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By Prof. C. GRABE and Prof. C. LIEBERMANN,
In Konigsberg. In Berlin.

Historical development of the synthesis of alizarin.

The discovery of artificial alizarin is the result of an investigation made by Grabe and Liebermann on the constitution of the most important coloring matter contained in the madder plant; that is, in solving a purely scientific problem. For this reason a few remarks may here be made on the most important theoretical results previously obtained in the many labors on alizarin.

Since Colin and Robiquet [Ann. Chim. Phys. xxxiv., 225] first isolated alizarin from the madder root in 1826, the formula of this coloring matter could never be considered definitely decided until 1868, as will be seen from a series of formulæ given for the same. Among these the formula $C^{10}H^6O^3$ [the older formulæ in which the atomic weights of C and O are half as great as those now employed, are translated in the following on the basis of C = 12 and O = 16] was considered the most probable by most chemists, until the question was definitely solved.

The basis of this formula was the discovery of the fact, by Schunk, [Ann. Chem. Pharm., lxvi., 174], in 1848, that alizarin on
526 oxidation gave an acid which he called alizaric acid. Gerhardt, [Compt. rend., v., Gerhardt and Laurent, 1849, 1222],

in his report on this work expressed the opinion that it was probably identical with the phthalic acid obtained by Laurent from naphthalin.

Wolff and Strecker [Ann. Chem. Pharm., lxxv., 1] experimentally showed this opinion to be correct in 1850. At the same time they deduced from the published analysis of alizarin and its salts the formula $C^{10}H^6O^3$, and showed the close relation between this coloring matter and the chloroxynaphthalic acid $C^{10}H^5ClO^3$, obtained by Laurent [Ann. Chim. Phys., lxi., 113] from naphthalin, which also forms phthalic acid by oxidation. They declared the chloroxynaphthalic acid to be chlorinated alizarin; a term which corresponds with the above formulæ, and which they also confirmed by the similarity of the properties and decomposition products of the two substances. They also attempted at that time to replace the chlorine in the chloroxynaphthalic acid by hydrogen in order to obtain alizarin. Although their experiments did not give the desired results, they still expressed their conviction that by employing the proper methods it will be possible to obtain alizarin from naphthalin. The work of Wolff and Strecker was convincing and their opinion was generally accepted, although Schunck in 1852 [Ann. Chim. Pharm., lxxxi., 336] again brought forward his formula $C^7H^5O^2$.

This fruitless attempt to obtain alizarin from naphthalin was followed by others. Roussin [Compt. rend., lii., 1033 and 1177] believed that he obtained it from binitronaphthalin, but his statements proved to be erroneous. [Liebermann showed that this compound, the naphthazarin, had the composition $C^{10}H^6O^4$. Ann. Chem. Pharm. clxii., 328.]

Martius and Griess [Ann. Chem. Pharm., cxxxiv., 375] succeeded in obtaining from naphthalin a compound which indeed also has the formula $C^{10}H^6O^3$; but this compound was also different from alizarin, notwithstanding that some of its general properties corresponded with those of alizarin.

This, however, did not refute the view taken of the derivation and formula of alizarin, since they might both be considered
527 isomeric naphthalin derivatives, and they were actually so considered.

The synthetical experiments which were made on the theory that chloroxynaphthalic acid was chlorinated alizarin were not successful, but still the close relation of the two was of the greatest importance for further study.

Strecker, who again took up his investigations on alizarin, first arrived at the correct formula for alizarin, $C^{14}H^8O^4$, on the basis of analyses made in 1866. He, however, confined himself to giving the formula in his text-book on organic chemistry (7 Ed., i., p. 816) (which then contained only a short review of organic compounds), without reason for the same. For this reason it was not generally known or recognized at the time. Only after the first publication of Gräbe and Liebermann [Ber. Chem. Ges., 1868, 149] did Strecker [Zeitschr. f. Chem., 1868, 263] publish his analyses and proofs in the Zeitschrift für Chemie, 1868.

In the meantime a further knowledge of alizarin was obtained by a method which was originally in no connection with the subject. Gräbe [Ann. Chem. Pharm., cxlvi. 1] in 1866, while making investigations on the chinon group, expressed the opinion that chloranilic acid contained no corboxyl group, as the true organic acids do, but that, like all chinons, it contains two atoms of oxygen, which are combined among themselves, and give an acid character to chloranilic acid, so that he considered it bioxybichlorchinon, corresponding to the formula

$$C_6Cl_2 \left\{ \begin{matrix} (O_2)'' \\ (OH)_2 \end{matrix} \right.$$

In connection with this, Gräbe, in an investigation on napthalin [Ann. Chem. Pharm., cxlix., 1], the first results of which [Ber. Chem. Ges., 1868, 36] were made known in January, 1868, pointed out that the chloroxynaphthalic acid was to be considered as chloroxynaphthachinon—

$$C_{10}H_4Cl \left\{ \begin{matrix} (O_2)'' \\ (OH) \end{matrix} \right.$$

528 and the compound of Martius and Griess as oxynaphthochinon—

$$C_{10}H_5 \left\{ \begin{matrix} (O_2)'' \\ OH \end{matrix} \right.$$

The analogy between chloroxynaphthalic acid—which was also seen in the fact that sodium amalgam decolorized its alkaline solutions, which, on exposure to the air, however, again assumed their original color, exactly as is the case with chloranilic acid—naturally gave rise to the opinion that alizarin was a similar acid, a so-called chinon acid. Gräbe and Lieberman [preliminary communications: Ber. Chem. Ges., 1868, 49, 104, 186; 1869, 14, 332, 678; 1870, 359, 634; full details: Ann. Chem. Pharm., supplementary vol. vii., 257, and clx., 121] took up their investigations from this point of view.

Since, at the beginning of this work, the formula of alizarin was not definitely known, no opinion could be formed from which hydrocarbon alizarin was to be derived. The first thing to be done, therefore, was to determine experimentally what is the mother substance of alizarin.

Baeyer [Ann. Chem. Pharm., cxl., 295] showed toward the end of 1866 that aromatic compounds, such as the oxindol derived from indigo, and phenol, which could not be reduced directly according to known methods, would give up their oxygen on heating with zinc dust. To this method, which seemed created for their purpose, Gräbe and Lieberman are indebted for the positive results which they obtained in their first experiments, showing alizarin to be a derivative of anthracence.

On heating alizarin with zinc dust they obtained a hydrocarbon, which they recognized to be identical with that found by Laurent and Dumas in coal-tar, and characterized by Fritsche and Anderson

as anthracene, $C^{14}H^{10}$, [compare the report on anthracene.] This decided what the mother substance of alizarin is, and made further analysis for determining the formula unnecessary. Originally they had the choice between the double formula of Schunck, $C^{14}H^{10}O^4$, and one which contains two atoms less of hydrogen.

529 In the first place, theoretical grounds decided the choice. In assuming ten atoms of hydrogen, the alizarin had to be considered as tetraoxyanthracene $C_{14}H_6(OH)_4$; while, according to the latter formula it could be considered bioxyanthrachinon,

$$C^{14}H^6\begin{cases}(O^2)''\\(OH)''^2\end{cases}$$

The deportment and composition of the salts, and particularly the benzoyl compound examined by Schützenberger [Matières colorantes, ii., 1; German translation, 1869, ii., 114] spoke against the former, but fully agreed with the latter formula. On thorough examination of the published analytical material, it was found that the analyses of sublimed alizarin, which are certainly the most correct, agreed very well with the formula $C_{14}H_8O_4$, and not with the one richer in hydrogen. To these analyses also belongs the first one ever made of alizarin. Robiquet obtained numbers which perfectly agree with the formula $C_{14}H_8O_4$, but which led to a much more complicated one, on account of the atomic weight of carbon not being exactly determined at that time. The analyses of unsublimed alizarin, without exception, also show too little hydrogen for Schunck's formula. The difference in carbon is probably due to impurity of the alizarin. Gräbe and Liebermann, therefore, in their first communication (Sitzung d. Chem. Ges., Feb. 24th, 1868,) gave the formula $C^{14}H^8O^4$ as the only admissible one, and on account of the above mentioned analogies they declared the alizarin to be bioxyanthrachinon,

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Purpurin, the other principal component of madder, the formula of which was still more uncertain than that of alizarin, was
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From this resulted the interesting fact that the two coloring matters

occurring in madder were also closely connected chemically, and justified the opinion that the other accompanying coloring matters—as, for instance, the pseudopurpurin—are also derivates of anthracene. The latter, according to analysis, is to be considered as tetraoxyanthrachinon,

$$C^{14}H^4 \begin{cases} (O^2)'' \\ (OH)^4 \end{cases}$$

After the alizarin was known with certainty to be a derivative of anthracene, the possibility of the reverse problem was taken into consideration—that is, to produce alizarin from anthracene. Without regard to any commercial value, this synthesis offered much interest from a scientific view, for examining the correctness of the above, and trying, for the first time, to realize the synthesis of an organic coloring matter.

It was of importance first to become better acquainted with anthracene, the derivatives of which had only been examined by Anderson. The difficulty of obtaining anthracene was a great drawback in the beginning. The synthetic formation of Limpricht and Berthelot, also the formation from alizarin, were impracticable on a large scale. The material employed by Anderson could not be had, and therefore the first material had to be made from high boiling tar in the laboratory. The liberality of C. A. Martius was of much influence on the rapid progress of the investigation. Gräbe and Liebermann received from him during the fall of 1868, al-
531 most a pound of hydro-carbon rich in anthracene, which he had found in an English tar distillery.

While studying the anthracene, Graebe & Liebermann came to the conclusion that the product of the direct oxidation of anthracene obtained by Laurent was the chinon of this hydrocarbon, and could be produced from this by replacing two atoms of hydrogen by two combined atoms of oxygen.

$C_{14}H_{10}$	$C_{14}H_8(O_2)''$
Anthracene.	Anthrachinon.

According to this, the anthrachinon, the history and preparation of which will be described below, was naturally considered the intermediate product between anthracene and alizarin; if the latter really was bioxyanthrachinon,

$$C^{14}H^6 \begin{cases} (O)^{2''} \\ (OH)^2 \end{cases}$$

Analogy with the previously mentioned chinon acids led to the artificial preparation by means of an intermediate chlorine or bromine substitution product. Bromine does not act on anthrachinon in the cold, but Graebe & Liebermann succeeded in obtaining a bromine substitution product by heating bromine and anthrachinon to 100° in a sealed glass tube. Contrary to all expectations it did not change by boiling with potash; but, as the temperature was raised,

and the caustic potash was freed from water, the characteristic color of alizarin potash appeared. Small as the amount obtained in the first tube was, it sufficed to determine the characteristic properties of alizarin. Scientifically, Graebe & Liebermann had solved the problem of the synthesis of alizarin, and found in it much support for the opinion they originally expressed in reference to this coloring matter.

The following equations represent the reactions, which first gave anthrachinon from anthracene, then bibromanthrachinon, and finally alizarin:

I. $C_{14}H_{10}+3O = C_{14}H_8(O_2)''+H_2O.$
Anthracene. Anthrachinon.

II. $C_{14}H_8(O_2)_{11}+4\ Br = C_{14}H_6Br_2(O_2)''+2\ BrH.$
Bibromanthrachinon.

III. $C_{14}H_6Br_2(O_2)''+2KOH = C_{14}H_6(OH)_2(O_2)''+2KBr.$
Alizarine.

The latter is, of course, contained in the alkaline fusion
532 (*Schmelze*) as alizarate of potassium, $C^{14}H^6(OK)^2(O^2)''$, and is precipitated by acids.

The preparation of bibromanthrachinon by this method was so laborious, that Graebe & Liebermann had to look for another method to obtain it. In consequence of experiments made on the bromine substitution products of anthracene, they arrived at a convenient method of preparing a tetrabromanthracene. This could be converted into bibromanthrachinon by oxidation. This method made it possible to obtain the alizarin more readily, and aroused hopes of its technical execution.

Here two more reactions had to be employed, but they generally succeeded pretty well. Anthracene was mixed with four atoms of bromine, under carbon disulphide, and bibromanthracene was obtained:

1.) $C^{14}H^{10} + 4Br = C^{14}H^8Br^2 + 2BrH.$
Anthracene. Bibromanthracene.

This bibromanthracene takes up four atoms of bromine in an atmosphere of bromine:

2.) $C^{14}H^8Br^2 + 4Br = C^{14}H^8Br^2,Br^4.$
Bibromanthracene. Bibromanthracene tetrabromide.

The latter, when boiled with alcoholic potash, furnishes the above mentioned tetrabromanthracene:

3.) $C^{14}H^8Br^2,Br^4 + 2KOH = C^{14}H^6Br^4 + 2BrK + 2H^2O.$
Tetrabromanthracene.

The tetrabromanthracene on oxidizing with nitric acid or nitric acid and chromate of potash, gave bibromanthrachinon:

4.) $C^{14}H^6Br^4 + 2O = C^{14}H^6Br^2O^2 + 2Br.$

And the fifth operation corresponded with the third one given

above, which converts the bibromanthrachinon into alizarine by fusing with potash or soda.

It was also shown that the same reactions take place with chlorine, and furnish alizarin, but with more difficulty.

533 The artificial alizarine, besides having the same composition, had also the same properties as vegetable alizarin. In hydrated alkalies it is soluble with a blue violet to purple color; the solutions of the alkali salts give with lime, baryta, lead, iron, alumina, and tin salts, lakes corresponding to the madder lakes. Cloth printed with mordants dyes exactly alike with both coloring matters. From all these salt-like compounds yellow flocculent alizarin is set free by the addition of a mineral acid. The artificial coloring matter shows the same solubilities, and the solutions of the alkaline salts the same absorption spectra which are known of the natural coloring matter. The free coloring matter sublimes in beautiful yellow to red needles, which cluster together like feathers. On oxidizing with nitric acid phthalic acid and oxalic acid are formed; heated with zinc dust the artificial alizarin is again converted into anthracene.

The above methods, which now, from a technical point of view, have only a historic interest and are therefore described without further detail, make up the subject of the patents taken out in England on the 18th of November, 1868, and then also in France, Prussia, most German states, Austria, Russia, and America. Gräbe and Liebermann made known to the scientific world the synthesis of alizarin on January 11th, 1869, (Ber. Chem. Ges., 1869, 14,) and the method (English Patent, 1869, 332) of production in a lecture to the Chemischen Gesellschaft, in Berlin, on June 28th. First by the publication of the French patent in the beginning of April, 1869, (Mon. Scient., 1869, 384,) and then by communications in the Berichte, these methods became generally known.

The discover*ies* of the synthesis of alizarin soon found it necessary to enter into connection with some large dye factory. This was necessary in order that the raw material could be more easily obtained and that the experiments could be made on a large scale and further developed. This could be done best with an establishment already in existence, where the doubtful question, whether this might be the basis of an industry with hopes of success, could be solved. One of

534 the chief difficulties experienced was the fact that the raw material was not only unknown in commerce, but also in the tar industry, and it was difficult to say whether it could ever be obtained in sufficient quantity; it was also doubtful whether the artificial alizarine could compete with the natural. Furthermore, there was much difficulty in transferring the above methods to a large scale. Gräbe and Lieberman, therefore, entered into connection with the Baden Anilin and Soda Works, in Ludwigshafen, on the Rhine, the largest works of the kind in Germany, even on the continent. Originally, the experiments were limited to the purification of the anthracene and the manufacture of anthrachinon by the second

mentioned bromine method, because this, notwithstanding its difficulties, showed some hopes of success. The latter was dropped as soon as the observation was made that the alizarin could be made more simply by means of anthrachinon sulpho-acids.

Production of Alizarin by means of Sulpho-acids.

Gräbe and Liebermann had originally attempted to obtain anthrachinonsulpho-acids by acting on anthrachinon with sulphuric acid; but they made the mistake of using too low heats; the temperatures they employed were not high enough, being not greater than those generally employed in the preparation of sulpho-acids. They had also been misled by the observation that anthrachinon could be sublimed unchanged from strongly-heated sulphuric acid. Therefore they hoped little from sulpho-acids, and gave all their attention to improving the above methods. This mistake was avoided, and the modification of the synthesis of alizarin, which forms the basis of the industry of to-day, was discovered first by Heinrich Caro, who, as an officer at the Baden Anilin and Soda Works, made it his task to give, in combination with Gräbe and Liebermann, life to the alizarin industry. Caro first noticed that anthrachinon, if heated with sulphuric acid to above 200°, would give sulpho-acids, which, on fusing with hydrate of potash, formed alizarin, the same as the bromine compound. Perkin noticed the same fact shortly after or at about the same time.

535 This method was further developed by Caro and the original discoverers, and the English patent was taken on June 25th, 1869 [Caro, Graebe, and Liebermann, Engl. patent, 1869, No. 1936]; the patent of Perkin is dated June 26th [Perkin, Engl. patent, 1869, No. 1948]. Two methods were discovered, analogous to the two bromine methods. In the first and most important, the anthracene is ozydized to anthrachinon; this is converted into sulphoacids by heating with sulphuric acid to 200° to 260°; and these, by the beautiful method of Kekulé, Wurtz and Dusart, by fusing with caustic potash or soda, are converted into alizarine.

The first process is therefore identical with the first bromine method given above. In the second method the sulphuric acid acts on the anthrachinon in such a manner that, besides the anthrachinonmonosulpho-acid as principal product, a small amount of anthrachinonbisulpho-acid is also formed. This was subsequently determined analytically by Graebe and Liebermann; in the patent only the anthrachinon sulpho acids are mentioned. From analogy, Perkin, in his paper [Jour. Chem. Soc. [2], viii, 133, and Ann. Chem. Pharm., clviii, 335], considered the bisulpho acid only; it is also formed in larger quantity by the excess of acid he employs in his method, than it is by the method of Caro, Graebe and Liebermann. Therefore, in the second process of making alizarin, the two following reactions take place:

II.
$$C_{14}H_8(O_2) + SO_4H_2 = C_{14}H_7\begin{cases}(O_2)\\SO_3H\end{cases} + H_2O$$
Anthrachinonmonosulpho-acid.

$$C_{14}H_8(O_2) + 2SO_4H_2 = C_{14}H_6\begin{cases}(O_2)\\(SO_3H)_2\end{cases} 2H_2O_2$$
Anthrachinonbisulpho-acid.

On fusing the two sulpho acids they give alizarin, exactly like the monobrom and dibromanthrachinon. [Graebe und Liebermann in der oben citirten Abhandlung.] The anthrachinonbisulpho acid behaves, for the greater part, if not altogether, like the monosulpho acid, and furnishes instead of the corresponding bioxyanthrachinon, essentially trioxyanthrachinon, the isopurpurin.

536 The formation of alizarin on fusing, then, corresponds to the following formulæ:

III.
$$C^{14}H^7\begin{cases}(O^2)\\SO^3Na\end{cases} + 3NaOH + O = C^{14}H^6\begin{cases}(O^2)\\(ONa)^2\end{cases} + SO^3Na^2 + 2H^2O$$

$$C^{14}H^6\begin{cases}(O^2)\\(SO^3Na)^2\end{cases} + 2NaOH = C^{14}H^6\begin{cases}(O^2)\\(ONa)^2\end{cases} + 2SO^3Na^2$$

To this, then, comes the formation of isopurpurin, which is considered further on, and corresponds to the following formula:

$$C^{14}H^6\begin{cases}(O^2)\\(SO^3Na)^2\end{cases} + 5NaOH + O = C^{14}H^5\begin{cases}(O^2)\\(ONa)^3\end{cases} + 2SO^3Na^2 + 3H^2O$$

The details of these methods are described in considering the technical preparation.

Analogous to the second bromine method, Caro, Graebe, and Liebermann also showed that alizarin may be obtained when anthracene is first converted into sulpho acids, and these then oxydized, whereby sulpho acids are formed, which, on fusing with alkalies, also furnish the coloring matter. Which anthracene sulpho acids and which anthrachinon sulpho acids are here formed has not been analytically determined. No formula can therefore be given with certainty. Since this method has not been technically developed, we give, in the following, the process as described in the patent.

Anthracene, with four parts of concentrated sulphuric acid, is heated for several hours to 100°, and then to about 150°. After diluting with water, the solution which contains anthracene sulpho acid and sulphuric acid is mixed with two or three parts of peroxid of manganese, then strongly boiled for some time, and evaporated to dryness. The sulphuric acid is then precipitated by caustic lime,

and the manganese removed; and finally the anthrachinon sulpho acid lime salt, which has gone into solution, is converted into a soda salt and fused in the above manner.

537 The patent of Caro, Gräbe, and Liebermann is dated one day earlier than that of Perkin. If any value is at all to be placed in the date, then Caro must certainly be mentioned first, since the application for a patent by the German chemist was delayed by an error.

The signing took place on June 15th, at the patent agent's in Berlin. In reference to the above two English patents, Perkin and the Baden Anilin and Soda Works, proprietors of Caro, Gräbe and Liebermann's patent, made an agreement, in consequence of which the patents became common property. By the publication of these patents, the sulphoacid methods of preparing alizarin became known, and a series of works were erected in states which gave no, or insufficient, protection to the patentees.

In Prussia Gräbe and Liebermann obtained a patent on the bromine method, but, curiously enough, could get none on the sulphoacid method, because this was not novel as compared with the other, and because the first patent did not include protection for improvements. In France they made use of the supplement patent privilege, which gives preference to the original discoverers during the first year, for improvements. It has been asserted that the sulpho-acid method was discovered at the works of Meister, Lucius, and Brüning, prior to the discovery by the above chemists. Since no proof of this is published by Meister, Lucius, and Brüning, and since private investigation could not prove this, it is thought, without desiring to diminish the merit of the above firm in having manufactured the alizarin soon, and on a large scale, that they are not to be mentioned among the inventors of the sulpho-acid method. [According to a private communication from Dr. Gessert, it is stated that Born discovered the sulpho-acid method in the fall of 1869, in the works of Gessert Bros., at Eberfeld, prior to obtaining a knowledge of the above patents.]

Besides the method just described, there is only one of technical importance, and which is used on a large scale. The same was found soon after the above at the same time by Perkin on the one side and Gräbe and Liebermann on the other. Perkin applied for

538 a patent in England November 17th, 1869. Gräbe and Liebermann published this method at the same time that Perkin's patent became known.

In this method, the formation of anthrachinon is avoided, and this compound is replaced by bichlor- or bibromanthracene, which, by the action of sulphuric acid alone, or in combination with an oxidizing agent, are also converted into anthrachinonsulpho-acids.

The description of this method, as one technically employed, will be given further on.

The reactions of the common method of Perkin and Gräbe and Liebermann are as follows:

Anthracene and chlorine give bichloranthracene.

I. $C^{14}H^{10}+4Cl = C^{14}H^{8}Cl^{2}+2ClH.$

Bichloranthracene.

Sulphuric acid converts this, by heating to above 200°, directly into anthrachinonbisulpho-acid, by forming at the same time sulpho-acid, and replacing two atoms chlorine by two atoms oxygen:

II. $C^{14}H^{8}Cl^{2}+3H^{2}SO^{4} = C^{14}H^{6}\left\{\begin{matrix}(O^{2})\\(SO^{3}H)^{2}\end{matrix}\right.+2ClH+SO^{2}$
$+2H^{2}O.$

A third reaction is the one corresponding to the former, fusing with caustic soda, whereby, under certain circumstances, isopurpurin is formed as principal product. The reaction with bibromanthracene is analogous; here bromine is chiefly formed in place of hydrobromic acid. The second method described by Perkin alone, differs from the first, the second operation (II.) being divided into two reactions. First, on treating chloranthracene with sulphuric acid at 130° to 150°, bichloranthracenebisulpho-acid is formed:

II*a*. $C^{14}H^{8}Cl^{2}+2SO^{4}H^{2} = C^{14}H^{6}\left\{\begin{matrix}Cl^{2}\\(SO^{3}H)^{2}\end{matrix}\right.+2H^{2}O,$

and oxidizing agents, like peroxide of manganese, convert this into anthrachinonbisulpho-acid:

II*b*. $C^{14}H^{6}\left\{\begin{matrix}Cl^{2}\\(SO^{3}H)^{2}\end{matrix}\right.+O^{2} = C^{14}H^{6}\left\{\begin{matrix}O^{2}\\(SO^{3}H)^{2}\end{matrix}\right.+2Cl.$

539 R. S. Dale and C. Schrolemmer [English patent, 1870, No. 261] took out another patent (January 24th, 1870) for preparing alizarin by means of sulpho-acids. The same is, however, only to be considered a modification of the second method mentioned in Caro, Gräbe, and Liebermann's patent. The patentees make the reactions II and III into one, by boiling anthracene with ten parts of sulphuric acid, and converting the sulpho-acids formed into alizarin in one operation. They fuse the same with caustic soda or potash, with the addition of oxidizing agents (alkaline nitrate or chlorate). This method has found no technical application.

It is yet to be mentioned that the sulphuric acid can effect the oxidation alone if long enough heated in great excess. On this action depends a French patent taken out by G. Auerbach and Th. Gessert, April 13th, 1874.

Methods of Preparing Alizarin by Means of Nitro and Amido Derivatives.

Besides the original method and the modification, which employs sulpho acids in place of chlorine and bromine, the further modification of employing nitro or amido derivatives has been proposed. The first communication on the possibility of obtaining alizarin by their aid is found in a patent by J. Brönner and H. Gutzkow (May 28th, 1869) [English patent, 1869, 1642]. This patent differs from

the former ones, which contain well-observed facts, in giving only superficial observations in a most obscure manner. As far as the description of Brönner and Gutzkow is intelligible, their method is as follows: Anthrachinon itself, or nitro or amido anthrachinon, on fusing with caustic potash give a substance which gives a yellow solution with alcohol, but they do not mention whether it has any relation to alizarin or not. The second body described by them, and which is soluble with a red color, is obtained by heating the oxidized product of anthracene (anthrachinon) dissolved in concentrated sulphuric acid, with nitric acid, or some other oxidizing agent, and precipitating with water. The same is, as has later been shown by Boettger and Petersen [Ber. Chem. Ges., 1871, 226] and
540 Liebermann, [Ber. Chem. Ges., 1871, 231] a derivative of anthracene, containing nitrogen, which has found no technical application.

If E. Kopp [Bolley Chem. Technologie; Die Naphtalin und Anthracenfarbstoffe] declares that "Brönner and Gutzkow employed sulphuric acid as a substitute for bromine, and by this means introduced into practice the discovery of Dusart, Wurtz, and Kekulé, known for several years to the theoretical and chemical world," this is simply a complete and inconceivable misunderstanding of the reaction. Brönner and Gutzkow employed sulphuric acid simply as a solvent for anthrachinon, in order to effect the nitration, and in their French patent [Mont. Scient., 1869, 865] they particularly state that they ascribe no specific action to the sulphuric acid, but that other acids or similar solvents can be employed with the same success. Furthermore, they state in their English patent that a temperature of 392° F. (200° C.) need not be exceeded; that is, a temperature at which no formation of anthrachinonsulpho acids takes place. And even in the improbable case, that in the method of Brönner and Gutzkow perhaps some anthrachinonsulpho acid or other sulpho acid is formed, it would pass into the wash water and be thrown away, because, according to the method described in Brönner and Gutzkow's patent, they only fuse the residue, insoluble in water; with caustic alkali.

The method of converting nitroanthrachinon into alizarin, which is indefinitely described in Brönner and Gutzkow's patent, was developed later (March, 1871) by Böttger and Petersen [Ann. Chem. Pharm., clx., 145]. They first converted anthrachinon into binitroanthrachinon, and then into biamidoanthrachinon:

$$C^{14}H^{6}(O^{2})+2NO^{3}H=C^{14}H^{6}(O^{2})(NO^{2})^{2}+2H^{2}O$$

Binitroanthrachinon.

$$C^{14}H^{6}(O^{2})(NO^{2})^{2}+12H=C^{14}H^{6}(O^{2})(NH^{2})^{2}+4H^{2}O$$

Biamidoanthrachinon.

By fusing with caustic potash, according to Böttger and Petersen, the first compound furnishes little; the second, more alizarin. Lieb-

ermann [Ber. Chem. Ges., 1871, 301] obtained, on fusing bi-
541 amidoanthrachinon with potash, also a coloring matter somewhat different from alizarin (isopurpurine). Later Böttger and Petersen [Ann. Chem. Pharm., clxvi., 147] found that by nitrating anthrachinon, mononitroanthrachinon might also be obtained—

$$C^{14}H^{6}(O^{2})+NO^{3}H=C^{14}H^{7}(O^{2})\ (NO^{2})+H^{2}O,$$

which on fusing with potassic hydrate gives directly alizarine. They handed the description of this method to the editor of the Annalen der Chemie und Pharmacie, on October 13th, 1872, but it was first published in 1873 at the author's request. Their former labors as well as the circumstance that their publication was postponed, justifies ascribing to them the discovery of this method, although the patent taken by W. Meister, Dr. E. Lucius, and Dr. A. Bruning (English patent, 1872, No. 2649), on the 6th of September, 1872, describes the same process. As far as known this method has not been practically employed; the following is a description of the patent. Anthrachinon is boiled for several hours with six parts of nitric acid of sp. gr. 1.5. It is completely soluble and the formation of mononitroanthrachinon is complete when a sample of the liquid no longer deposits anthrachinon on cooling. The nitro-product is precipitated with water and washed. One part of the dry substance is heated with 9 to 12 parts soda or potash lye of sp. gr. 1.3 to 1.4, to 170° to 230°, until the formation of the coloring matter is complete. From the filtered aqueous solution the coloring matter is precipitated by an acid.

Still to be cited for the sake of completeness is a *pli cachete* which was deposited by Girard (Bull. Soc. Ind., Mulhouse, 1875, 154) October 5th, 1869, and published January 3, 1872, and which seeks to appropriate modifications of the original method of Graebe and Liebermann and contains a series of reactions which are probably formed after the representation of the formation of chloroxynaphthalic acid
from naphthalin, but depend on superficial and incorrect re-
542 actions. In the main points they agree with the second of the original methods of Graebe and Liebermann. Girard treats the anthracene which boils at 300° to 350°, its isomers and homologues (!), with nitric acid and chlorate of potash in order to obtain *tetra-chlorinated* compounds, which he oxidizes with nitric acid or metallic oxides to bichloranthrachinon and the chloride of (*chlorur*) chloroxyanthranyl (!). In order to convert these substances into alizarin, they are treated with alcoholic soda and metallic oxides (zinc, lead or copper oxide for removing the last traces of chlorine.) The statement of Carstanjen (Ber. Chem. Ges., 1870, 545, and Ann. Chem. Pharm., clxi., 305), that bichloranthrachinon, which when fused with caustic potash gives alizarin, is formed in small quantity when anthracene is treated with chromoxychloride, is based on more reliable observations.

According to Wartha (Ann. Chem. Pharm., clxi, 305), anthra-

chinon may be converted directly into alizarin by fusing with caustic potash in presence of alcohol, as has been indistinctly stated in the patent of Bronner and Gutzkow. Graebe and Lieberman did not succeed in executing this reaction.

In reference to other formations of alizarin and anthracene the behaviour of oxyanthrachinon and anthraflavic acid, spoken of below, is to be referred to. Here, however, no new reaction takes place; it only depends on intermediate products between the anthrachinon sulpho acids and alizarin (or isopurpurin, as the case may be.)

As may be seen from the whole representation of the alizarin synthesis, only one has become essentially technical; that is the employment of sulpho-acids, and particularly the one which is derived from anthrachinon.

The methods referred to will be therefore described in the following as far as the secrecy with which the special methods are kept at the works will permit. Of the works which have succeeded in producing alizarin on a large scale are to be mentioned besides the Baden Anilin and Soda Works at Ludwigshafen and Perkin & Son in London, in the first place, Meister, Lucius & Bruning in Hoechst,
and also Gessert Bros. in Elberfeld. The latter two works
543 have at times advanced beyond the others, and they therefore
deserve the credit of having in a prominent and speedy manner secured the success of the alizarin industry.

The names of the technologists and chemists who have distinguished themselves in the development of the alizarin industry are difficult to mention, since their activity is generally concealed from the public. Still we believe that besides Caro and Perkin, the directors Engelhorn, A. & C. Clenon and C. Glaser, of the Baden Anilin and Soda Works, the chiefs of the house of Meister, Lucius & Bruning, and F. Riese; and J. Gessert and C. Born, of Gessert Bros., may be mentioned.

Technical Preparation of Anthrachinon.

The first intermediate member in the conversion of anthracene into alizarin was discovered by Laurent [Ann. Chim. Phys. (3), lx., 220; lxvi., 148] in 1835, and described as paranaphthalese, later as anthracenuse. He obtained it by oxidizing anthracene with nitric acid. Anderson [Ann. Chem. Pharm., cxxii., 294; Transac. of the Royal Soc. of Edinburgh, 1862, 681] obtained it in the same way, and introduced for it the name oxanthracene. This method of preparation offers difficulties in practice, because there are always some nitro-products formed which are difficult to separate. Fritsche [Petersburger Akademieberichte, xiii., 531], as also Gräbe and Liebermann, showed, in 1868, that it is more readily and better obtained by oxidizing with chromic acid, whereby it is advantageous to use glacial acetic acid as solvent. Gräbe and Liebermann also employed chromate of potash instead of chromic acid, and the process is de-

scribed in their first patent. This opened a way for preparing anthrachinon on a large scale.

The method of oxidizing anthracene in glacial acetic acid solution, which is certainly the best on a small scale, and which, as Luck has shown, (see report on anthracene,) is excellently adapted for the analysis of commercial anthracene, had to be so modified on a large scale that the use of glacial acetic acid could be avoided. It may be justly assumed that all works which experimented on the pro-
544 duc-[have at times advanced beyond the others, and they there]tion of alizarin on a large scale, employed chromate of potash and dilute sulphuric acid in place of chromic acid and glacial acetic acid. The advantage offered by glacial acetic acid in dissolving and completely exposing to the oxidizing action the hydrocarbon had to be secured in another way. Two methods have been found available, and were probably generally tried. In the first place, a liquid hydrocarbon, or one fusing at low temperature, could be added to the anthracene in order to have a fused mass for the oxidizing action; or complete oxidation could be obtained by a very fine division of the anthracene, which can more readily be obtained in practice than in the laboratory. By developing the method of oxidizing anthracene with bichromate of potash and dilute sulphuric acid, it has become possible to make it an operation which can be conducted on the largest scale. Anthracene, in accordance with the following formula, requires three atoms oxygen for oxidation:

$$C^{14}H^{10}+3O=C^{14}H^{8}O^{2}+H^{2}O.$$

Theoretically, therefore, 100 parts anthracene require 167 parts bichromate of potash. The amount required in practice depends on the percentage of anthracene in the hydrocarbon employed, and the nature of the admixtures. In general, $1\frac{1}{2}$ parts bichromate of potash are considered necessary for oxidizing 1 part of the anthracene employed.

The second difficulty to be overcome was the purification of the crude anthrachinon obtained by oxidation. The same contains unchanged hydrocarbons, as well as phenanthren, and other products of oxidation containing chromium, which have not been further examined. The purification has been tried in three ways, and carried out on a large scale. The anthrachinon was first purified by recrystallizing from benzol or petroleum ether; secondly, it has been separated by distillation and sublimation. Combinations of both methods have also been employed; thirdly, it has been purified by heating with concentrated sulphuric acid. The last method was finally found to be most advantageous, and is generally em-
545 ployed. According to a private communication from Dr. Gessert, it was discovered by him, and first employed in his works on a large scale. On the process he communicates the following: "The crude anthrachinon is heated to 110° in kettles having steam jackets, with three parts of sulphuric acid of 66° B., then

drawn off for crystallization, and afterward boiled with water. This method requires great care, and can easily entail loss by the fine separation of the chinon." This purification depends on the fact than anthrachinon on being heated with sulphuric acid of 66° B. to 100° to 110° [in the factory of Bindschedler & Busch a temperature of 130° is used (Ber. Chem. Ges., 1874, 1107)] is dissolved, but not attacked, while the impurities are destroyed, or form soluble sulphoacids. The latter are removed by washing with water, and the anthrachinon is dried. It is of great importance in this method that the anthrachinon separates distinctly crystalline, and can therefore be washed without loss.

In connection with the production of anthrachinon, and supplementing it, the employment of the liquors containing chromium has become of importance in the manufacture of alizarin.

Further modifications of the anthrachinon production have been tried, but have found no application. This is true of the methods which replace chromate of potash by other oxidizing agents, as well as those which employ hydrochloric or nitric acid in place of sulphuric acid. The employment of nitric acid is mentioned in the patent of Meister, Lucius & Brüning.

Also the methods of obtaining anthrachinon from anthacene indirectly have been found impracticable on a large scale. To these belongs the observation made by Grabe and Liebermann, that the bichloranthracene, which is produced by the direct action of chlorine on anthracene, furnishes on oxidation anthrachinon with the liberation of chlorine:

$$C^{14}H^{8}Cl^{2} + 2O = C^{14}H^{8}O^{2} + Cl^{2}.$$

The anthrachinon consists of needle-shaped crystals, whether it is obtained by sublimation, crystallization, or by precipitation
546 from sulphuric acid with water. The size and color depends on the method of purification.

The sublimed anthrachinon forms large thick needles or prisms of a pretty intense yellow color, while that separated from sulphuric acid consists of small, almost colorless needles. If crystallized from solvents, it has properties which stand between the above.

Anthrachinon melts at 275° to 278°, and sublimes readily at about the same temperature. Its boiling point lies between that of mercury (360°) and that of sulphur (440°). It is difficultly soluble in solvents like alcohol, ether, and benzol.

It is characterized in comparison with the chinons of other hydrocarbons by its great stability. Without this property the whole manufacture of alizarin would be impossible, since in the formation, in the action of sulphuric acid, and in the fusion, comparatively high temperatures are employed.

Similar to syntheses of oxyanthrachinon mentioned below, the anthrachinon has itself been obtained synthetically. It is formed in small quantity, as was first observed by Kekulé and Franchimont [Ber. Chem. Ges., 1872, 908] as a by-product in the preparation of

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545 ployed. According to a private communication from Dr. Gessert, it was discovered by him, and first employed in his works on a large scale. On the process he communicates the following: "The crude anthrachinon is heated to 110° in kettles having steam jackets, with three parts of sulphuric acid of 66° B., then

drawn off for crystallization, and afterward boiled with water. This method requires great care, and can easily entail loss by the fine separation of the chinon." This purification depends on the fact than anthrachinon on being heated with sulphuric acid of 66° B. to 100° to 110° [in the factory of Bindschedler & Busch a temperature of 130° is used (Ber. Chem. Ges., 1874, 1107)] is dissolved, but not attacked, while the impurities are destroyed, or form soluble sulphoacids. The latter are removed by washing with water, and the anthrachinon is dried. It is of great importance in this method that the anthrachinon separates distinctly crystalline, and can therefore be washed without loss.

In connection with the production of anthrachinon, and supplementing it, the employment of the liquors containing chromium has become of importance in the manufacture of alizarin.

Further modifications of the anthrachinon production have been tried, but have found no application. This is true of the methods which replace chromate of potash by other oxidizing agents, as well as those which employ hydrochloric or nitric acid in place of sulphuric acid. The employment of nitric acid is mentioned in the patent of Meister, Lucius & Brüning.

Also the methods of obtaining anthrachinon from anthacene indirectly have been found impracticable on a large scale. To these belongs the observation made by Grabe and Liebermann, that the bichloranthracene, which is produced by the direct action of chlorine on anthracene, furnishes on oxidation anthrachinon with the liberation of chlorine:

$$C^{14}H^{8}Cl^{2} + 2O = C^{14}H^{8}O^{2} + Cl^{2}.$$

The anthrachinon consists of needle-shaped crystals, whether it is obtained by sublimation, crystallization, or by precipitation
546 from sulphuric acid with water. The size and color depends on the method of purification.

The sublimed anthrachinon forms large thick needles or prisms of a pretty intense yellow color, while that separated from sulphuric acid consists of small, almost colorless needles. If crystallized from solvents, it has properties which stand between the above.

Anthrachinon melts at 275° to 278°, and sublimes readily at about the same temperature. Its boiling point lies between that of mercury (360°) and that of sulphur (440°). It is difficultly soluble in solvents like alcohol, ether, and benzol.

It is characterized in comparison with the chinons of other hydrocarbons by its great stability. Without this property the whole manufacture of alizarin would be impossible, since in the formation, in the action of sulphuric acid, and in the fusion, comparatively high temperatures are employed.

Similar to syntheses of oxyanthrachinon mentioned below, the anthrachinon has itself been obtained synthetically. It is formed in small quantity, as was first observed by Kekulé and Franchimont [Ber. Chem. Ges., 1872, 908] as a by product in the preparation of

benzophenon from benzoate of lime. This synthesis induced Zincke [Ber. Chem. Ges., 1873, 307] to first express the opinion that anthrachinon is to be considered as a double keton,

$$C^6H^4\begin{matrix}CO\\CO\end{matrix}C^6H^4,$$

an opinion which is considered by chemists who have been employed with this subject lately as the most probable.

Behr and Van Dorp [Ber. Chem. Ges., 1874, 578] found that the tolyphenylketon, which is produced from benzoic acid and toluol, if passed over heated oxide of lead furnishes anthrachinon. The oxide of lead acts as an oxidizing agent, as shown in the formula:

$$\underset{\text{Tolyolphenylketon.}}{C^{14}H^{12}O} + 3O = \underset{\text{Anthrachinon.}}{C^{14}H^8O^2} + 2H^2O.$$

547 According to the same chemists [Ber. Chem. Ges., 1874, 578], it is also formed by heating *B* benzoylbenzoic acid, which is derived from toluol, with phosphoric anhydride:

$$\underset{\text{Benzoylbenzoic-acid.}}{C^{14}H^{10}O^3} = C^{14}H^8O^2 + H^2O.$$

Liebermann [Ber. Chem. Ges., 1874, 805] observed that, by employing fuming sulphuric acid in place of phosphoric anhydride, anthrachinon sulpho-acids could be obtained directly.

Anthrachinon has also been obtained from phthalic acid. According to Piccard, [Ber. Chem. Ges., 1874, 1765,] it is formed in small quantity by heating the chloride of phthalic acid with benzol and zinc dust to 220°:

$$C^6H^4\begin{matrix}COCl\\COCl\end{matrix} + C^6H^6 = C^6H^4\begin{matrix}CO\\CO\end{matrix}C^6H^4 + 2HCl.$$

At present it does not seem probable that anthrachinon, or anthrachinon sulpho acids, will be produced on a large scale by either of the above methods, or similar ones, by starting from benzoic acid or toluol, instead of from anthracene; but it cannot positively be said to be impossible, and for this reason we have given the above formulæ.

Preparation of anthrachinon sulpho-acids.

The main points of the conversion of anthrachinon into sulpho-acids are contained in the patents of Caro, Grabe and Liebermann, and Perkin. The further development on a large scale, leaving out of sight the construction of the proper apparatus, relates to the proper proportions of anthrachinon and sulphuric acid, the best concentration of the latter, and the proper temperature. The latter is of the greatest importance, because it principally depends on it, as in the formation of all sulpho acids, whether a mono- or disulpho-acid will be formed, and it also influences the formation of isomeric compounds, as was first shown by Kekulé in the formation of phenol-sulpho-acids.

The proportion which every factory has found the best has been

kept secret; we therefore describe the process in the following, as given by the patents:

548 According to Caro, Grabe, and Liebermannn, anthrachinon is heated with three times its weight of sulphuric acid of 1.848 to about 260°, until the mixture contains no longer an appreciable amount of anthrachinon, which can be determined by a sample giving a clear mixture with water. After cooling and diluting with water, it is neutralized with lime, filtered, and the filtrate decomposed by carbonate of soda or potash, best in solution. It is then filtered from the carbonate of lime, and the filtrate evaporated to dryness, whereby the potassium or sodium salts of the anthrachinon sulpho-acid are obtained in a dry state.

Perkin employs, according to his patent, 5 parts English sulphuric acid, and heats almost to boiling, or he employs 4 parts fuming sulphuric acid, and heats, to 180° to 220°, and then proceeds exactly like Caro, Grabe, and Liebermann.

According to the analytical examination of Grabe and Liebermann, by employing the method of the first cited patent anthrachinon monosulpho-acid is essentially produced. By employing the proportions of Perkin, bisulpho-acid is more largely produced, although not exclusively.

The addition of fuming sulphuric acid to the English had been found advantageous some time ago, but it was only lately that it was used exclusively. For this purphose a solid acid, which is obtained from Bohemia, is employed, and which contains almost one molecule of anhydride (40 per cent., about) to one molecule of sulphuric acid. In using this acid the temperature need not be raised so high as formerly; the yield of sulpho-acids is also greater.

In manufacturing on a large scale, the kettles must be provided with eduction pipes for carrying off the vapors of sulphuric and sulphurous acids, the formation of which cannot be altogether avoided.

Phthalic acid was found as a by-product if the operation was not properly conducted. According to Weith and Bindschedler, [Ber. Chem. Ges., 1874, 1107,] on heating 1 part anthrachinon with three to four parts fuming sulphuric acid, phthalic acid was formed to the amount of 10 per cent. of the weight of anthrachinon.

549 *Fusing of the Anthrachinon Sulpho-Acid with Caustic Soda.*

Caro, Gräbe and Liebermann give the following method for converting sulpho-acids into alizarin in their patent: One part of the soda salt of these acids is heated with two or three parts of caustic soda or potash, best with the addition of water, to a temperature of 180° to 260°, until the addition of acid to a sample gives a heavy precipitate of the coloring matter. After completing this operation the fused product is dissolved in water, and mixed with acid, either directly or after filtering. The separated coloring matter is collected on a filter and washed.

Perkin describes about the same method, and adds that a mixture

of two parts caustic potash and one part caustic soda is particularly well adapted.

On a large scale, the conversion of sulpho-acids into alizarine is now effected almost altogether, if not exclusively, by caustic soda.

In fusing the anthrachinon sulpho-acids, several changes of color are to be noticed, since several intermediate products are formed, like the oxyanthrachinon between anthrachinon sulpho-acid and alizarine, or the oxyanthrachinon sulpho-acid examined by Perkin and by Gräbe and Liebermann,—

$$C^{14}H^{6}\begin{cases} O^{2} \\ OH \\ SO_{3}H \end{cases}$$

between the anthrachinon bisulpho-acid and alizarine or isopurpurin. The following formulæ will show this:

$C^{14}H^{7}\begin{cases} O^{2} \\ SO^{3}H \end{cases}$ Anthrachinonsulpho-acid. $C^{14}H^{7}\begin{cases} O^{2} \\ OH \end{cases}$ Oxyanthrachinon. $C^{14}H^{6}\begin{cases} O^{2} \\ (OH)^{2} \end{cases}$ Alizarin.

$C^{14}H^{6}\begin{cases} O^{2} \\ (SO^{3}H)^{2} \end{cases}$ Anthrachinon bisulpho-acid. $C^{14}H^{6}\begin{cases} O^{2} \\ OH \\ SO^{3}H \end{cases}$ Oxyanthrachinon sulpho-acid. $C^{14}H^{6}\begin{cases} O^{2} \\ OH \\ OH \end{cases}$ Alizarin or Anthraflavic acid. $C^{14}H^{5}\begin{cases} O^{2} \\ (OH)^{3} \end{cases}$ Isopurpurin.

550 Therefore the remainder of sulphuric acid $SO^{3}H$ is replaced by hydroxyl, OH, and oxidation takes place at the same time by hydroxyl replacing hydrogen during the fusion. As far as has been observed, it seems that only the anthrachinon monosulpho-acid will produce alizarine, while the anthrachinon bisulpho-acid produces isopurpurin.

Hydrochloric or sulphuric acid is employed for precipitating the alizarin; on account of the sulphurous acid evolved, the operation must be conducted in vessels provided with eduction tubes. The sulphurous acid has so far generally been lost.

The separated alizarin, which has a brownish yellow color, must be washed with the greatest care, to free it from all the salts and acids which may be in the solution. It has not been brought into commerce yet in a dry state, but in the more convenient form of a paste. This generally contains 10 per cent. of the coloring matter, but there are also pastes sold containing 15 or 20 per cent.

With moderate action of sulphuric acid on anthrachinon, anthrachinon monosulpho-acid is essentially formed, which, on fusing, gives a coloring matter, which is particularly rich in alizarine, and is known in commerce as "alizarin for violet" (V. I., etc.) With alumina mordants it gives a blueish red, and with iron mordants a pure violet. If the action of the sulphuric acid is longer continued, a richer bisulpho-acid is formed, and this gives rise to the coloring matters containing more isopurpurin which give a pale violet, but a very bril-

liant yellowish red. These are marked "alizarin for red," (V. III., or R., etc.)

Preparing Anthrachinon Sulpho-Acids by means of Bichloranthracene.

The above-mentioned method, discovered by Perkin, and by Gräbe and Liebermann, in which the bichloranthracene is made an intermediate product between anthracene and the anthrachinon sulpho acids, in place of anthrachinon, has been used on a large scale, particularly in the works of Perkin & Son.

The product is essentially an alizarine for red. About the
551 method, we can only make statements contained in Perkin's patent.

He gives two methods for making the bichloranthracene. According to the first the anthracene in thin layers (about one half inch thick) is exposed to action of chlorine gas for twenty-four hours.

In the second method, four to five parts benzol are poured over 1 part anthracene, and then chlorine gas is passed through until the whole forms a crystalline mass. The liquid is then drained off, and the benzol removed by distillation. The product obtained by either of the two methods is best purified by crystallization, when it forms beautiful yellow needles fusing at 205°.

The conversion of bichloranthracene into anthrachinon sulpho-acids can be directly accomplished by sulphuric acid. According to Perkin, it is heated to 210°, and it is best to employ fuming sulphuric acid. The chlorine escapes as hydrochloric acid; the vessels must therefore be provided with eduction pipes. The sulpho-acids produced consist essentially of anthrachinon bisulpho-acid, and are further treated as described above.

Besides this method, Perkin has given a second, in which a special oxidizing agent is employed. The bichloranthracene is heated with 4 to 5 parts concentrated or fuming sulphuric acid to 130° to 150°, until addition of water yields a clear solution; then 3 to 4 parts of water, and peroxide of manganese in excess are added. Then it is boiled until a sample diluted with water no longer floresces; that is, until the first formed sulpho-acids of bichloranthracene are converted into anthrachinon sulpho-acids. Then milk of lime is added, and the solution of the anthrachinon sulpho-acid salts treated as in the older methods.

In connection with the description of the technical methods, we will describe in the following the products which are formed simultaneously with the alizarine in the fusing operation, and which pass into the commercial varieties.

552 *Isopurpurin*, $C^{14}H^5O^2(OH)^3$.

As has already been mentioned in the introduction, when anthrachinon sulpho-acids are fused with caustic soda, they form, besides alizarin, a greater or less quantity of a coloring compound, which is similar to purpurin. It is therefore contained in the com-

mercial alizarin in variable quantity; least in alizarin for violet, and most in alizaarin for red. It cannot be called a by-product, because in the production of certain red colors it has advantages over alizarin. The opinion has been stated above that it is formed from anthrachinon bisulpho-acids. With a certainty this has not yet been proven; though the circumstance that it can be formed from anthrachinon sulpho-acid salts, which, according to analysis, stand between mono and disulpho-acids, seems to speak in favor of this opinion, and against the one that it is formed from a trisulpho-acid.

From madder purpurin, which has not yet been found in artificial alizarin, it differs essentially in its properties. Auerbach (Monit. Scient., 1872, 686,) who made the first communication on it, called it isopurpurin. (Perkin Jour. Chem. Soc. 2, xi, 415; Jour. f. Prakt. Chem., xiii, 241, 1873,) to whom we are indebted for a thorough investigation of the same, named it anthrapurpurin. According to Perkin, the isopurpurin is best separated from alizarin by dissolving a mixture of the two in a dilute solution of carbonate of soda, and mixing it with freshly precipitated aluminic hydrate, whereby the alizarin is combined and the isopurpurin goes into solution. For complete purification, it is advantageous to boil the isopurpurin, which has been precipitated by hydro-chloric acid, with alcoholic soda, to form the difficultly soluble soda compound. The colors which it produces with alumina are brilliant yellowish red, while the iron mordants produce a pale gray color. They resist soap as well as alizarin, giving this material decided advantages over purpurin. It is said to be less adapted for Turkey red dyeing than the material rich in alizarin; most likely it is more easily attacked in brighten-
553 ing than alizarin. The composition was first determined by Auerbach, and then by Perkin, by studying the derivatives. It is, like purpurin, trioxyanthrachinon.

$$C^{14}H^5\begin{cases}(O^2)\\(OH)^3\end{cases}.$$

By-products of Alizarin.

As an actual by-product of alizarin, anthrachinon is to be mentioned, which may form in considerable quantity if the fusing process is not properly conducted, but its presence in artificial alizarin can probably never be altogether avoided. It can form from anthrachinon sulphoacid according to the formula:

$$C^{14}H^7\begin{cases}O^2\\SO^3Na\end{cases}+NaOH = C^{14}H^8O^2 + Na^2SO^4.$$

But it is more likely that it is formed by a process of reduction, since, according to an observation by Grabe, the solutions of anthrachinon sulpho-acid salts immediately separate anthrachinon on the addition of sodium amalgam.

In the following formula, anthrachinon is formed by the action of nascent hydrogen on the sodium salt of anthrachinon sulpho-acid:

$$C^{14}H^7\begin{cases}O^2\\SO^3Na\end{cases}+2H=C^{14}H^8O^2+SO^3NaH.$$

In the alkali fusions, particularly if the temperature is high enough, hydrogen is readily formed. In concurrence with this, anthrachinon forms most abundantly when the temperature is too high. The presence of anthrachinon is most readily detected by sublimation when the chinon first sublimes; or by dissolving in dilute nitric acid whereby the anthrachinon is not attacked. Since it is probably never absent altogether it might serve for distinguishing the artificial alizarin from the extracts of madder. The anthrachinon has no influence on the dyeing, and there is no reason for separating it as long as present in such small quantity as it is in the commercial products.

In the original fusion, part of the anthrachinon is reduced to anthrahydrochinon and passes into solution when this is exhausted with water, but separates on standing.

554. *Oxyanthrachinon.*

Another by-product, which is also probably never wanting in artificial alizarin, is the oxyanthrachinon. It was first found in artificial alizarin by Glaser and Caro, and its composition and formation were determined by Grabe and Liebermann and also by Liebermann alone [Ber. Chem. Ges., 1871, 108; 1872, 268]. Its composition is intermediate between that of anthrachinon and alizarin:

$C^{14}H^8O^2$	$C^{14}H^7\begin{cases}O^2\\OH\end{cases}$	$C^{14}H^6\begin{cases}O^2\\(OH)^2\end{cases}$
Anthrachinon.	Oxyanthrachinon.	Alizarin.

It is formed when the temperature in the fusing process is as low as possible, and owes its formation to the anthrachinon mono-sulpho acid:

$$C^{14}H^7\begin{cases}O^2\\SO^3Na\end{cases}+NaOH=C^{14}H^7\begin{cases}O^2\\OH\end{cases}+SO^3Na^3.$$

It is also formed analogously from monobromanthrachinon.

In the soda fusion it is further oxidized to alizarin, and therefore forms an intermediate product between monosulpho-acid and alizarin. Its presence in artificial alizarin does not change the colors in dyeing, but is injurious in reducing the percentage of real coloring matter, because it forms no insoluble lake.

Oxyanthrachinon may be detected in and separated from alizarin by its calcium, barium, and lead salts, which are soluble in water, while the corresponding salts of alizarin are not. The commercial alizarin is warmed with the carbonates or hydrates of the metals named, best with lime or baryta water, and then the oxyanthrachinon is precipitated from the filtrate by addition of acid. The oxyanthrachinon forms after recrystallizing or subliming gold-yellow nee dles or flakes, gives blood-red solutions with alkalies, and produces no colors on mordanted cloth, because its alumina and iron salts are soluble.

555 *Anthraflavic Acid.*

The anthraflavic acid $C^{14}H^6O^2(OH)^2$ discovered by Perkin [Jour. Chem. Soc. (2), ix., 1109; and (2) xi., 19] and Schunck [Chem. News, xxiii., 157] is very similar to oxyanthrachinon. One would certainly consider it identical with the latter if the analysis of Perkin did not refute this and show it to be isomeric with alizarin. Like oxyanthrachinon it is converted into alizarin by strongly fusing with caustic soda. Since nothing further is known about the alizarin so obtained and the transformation of anthraflavic acid into alizarin is remarkable, it may be possible that the coloring matter obtained is trioxyanthrachinone (isopurpurin) and then the behavior of the anthraflavic acid would also be analogous to that of oxyanthrachinon in this respect.

The isoalizarin of Rochleder (Ber. Chem. Ges., 1870, 694), the pseudopurpurin (Jour. f. Prakt. Chem. xcvi., 263) and the xanthopurpurin of Schutzenberger (this is isomeric with alizarin), have not been found in artificial alizarin.

Formation of purpurin from alizarin.

Indirectly F. de Lalande succeeded in producing purpurine synthetically. According to a method which he patented July 6th, 1874 (French patent No. 104,146 printed in Monit. Scient., 1874, 1149) a coloring matter is obtained by the oxidation of alizarin, of which Lalande says that it is identical with the purpurin from madder [Compt. rend., Sept. 14th, 1874; Ber. Chem. Ges. 1874, 1515]. A solution of alizarin in eight or ten parts of sulphuric acid of 66° is heated to 120° to 150°, with an amount of peroxide of manganese or arsenic acid (equal to or half as great as that of alizarin); if peroxide of manganese is employed, the oxidation will also take in the cold. The reaction is complete when a drop of the solution will dissolve with a red color in alkaline water. The mass is then put into twenty or thirty times its own weight of water, and after boiling, the separated coloring matter is collected on filters. Ac-
556 cording to the author, an alizarin can be obtained containing any desired amount of purpurine, depending on the duration of the process.

It cannot be said whether this method will become of technical importance.

According to Baeyer and Caro [Ber. Chem. Ges., 1875, 152] the chinizarin also furnishes purpurin under the same conditions.

Formation of Oxyanthrachinons from Oxybenzoic Acids.

A series of compounds, which belong to the same class with alizarin and the oxyanthrachinons mentioned, have been obtained synthetically from oxybenzoic acids. Although these methods have thus far had only a scientific interest, we mention them in this place, because it is not impossible that they may yet find technical employment. The first fact in this relation was proved by B. Jaffé [Ber.

Chem. Ges., 1870, 694]. He showed (1870) that rufigallic acid, which was first obtained by Robiquet as a brown body, in treating gallic acid with concentrated sulphuric acid, when heated with zinc dust, like alizarin, formed anthracene, and was therefore to be considered as hexaoxyanthrachinon.

In the formation of rufigallic acid, two molecules of gallic acid combine, losing two molecules of water:

$$2C^6H^2(OH)^3COOH—2H^2O=C^{14}H^2(O^2)(OH)^6.$$

The formation of this anthracene derivative is analogous to the synthesis of anthracene from benzylchloride, toluol, and benzytoluol. [Compare article on anthracen.]

Barth and Senhöfer [Ann. Chem. Pharm., clxx., 100] have generalized this reaction, and shown that the oxybenzoic acid forms a compound which is isomeric with alizarin, the anthraflavon [Ann. Chem. Pharm., clxiv., 113] $C^{14}H^6(O^2)(OH)^2$ [Ann. Chem. Pharm., clxiv., 113]; and that the dioxybenzoic acid is converted into a tetraoxyanthrachinon, the anthrachryson $C^{14}H^4(O^2)(OH)^4$, which therefore has the same composition as the pseudopurpurin.

Both these compounds give no madder-like colors on mor-
557 danted cloth, but only faint reddish-yellow colors passing into gray. The coloring matter obtained by Anderson from opianic acid, and which was originally considered to be alizarin, has the same composition. Liebermann and Chojnacki [Ann. Chem. Pharm., clxii., 321] pointed out that it was to be considered as a tetraoxyanthrachinon, and that it was probably produced from hypogallic acid, $C^6H^3(OH)^2COOH$, in the same manner that rufigallic acid is formed from gallic acid. For this reason they gave it the name rufiopin.

According to the method of combining two molecules of oxybenzoic acid, with the loss of water, four oxyanthrachinons have been obtained thus far. This reaction is best explained by assuming anthrachinon to be a double keton, as has been mentioned under anthrachinon. According to their formation, the oxy groups in this class of oxy derivatives are equally divided among the two benzol rings, while in alizarin they are contained in one. The formulæ of the compounds named are therefore as follows:

$C^6H^3(OH <\begin{matrix}CO\\CO\end{matrix}> C^6H^3(OH)$, anthraflavon.

$C^6H^2(OH)^2 <\begin{matrix}CO\\CO\end{matrix}> C^6H^2(OH)^2$, anthrachryson and rufiopin.

$C^6H(OH)^3 <\begin{matrix}CO\\CO\end{matrix}> C^6H(OH)^3$, rufigallic acid.

None of these compounds is identical with any of those derived from the vegetable kingdom, nor with the oxy derivatives of anthrachinon derived from anthracene.

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Both these compounds give no madder-like colors on mor-
557 danted cloth, but only faint reddish-yellow colors passing into gray. The coloring matter obtained by Anderson from opianic acid, and which was originally considered to be alizarin, has the same composition. Liebermann and Chojnacki [Ann. Chem. Pharm., clxii., 321] pointed out that it was to be considered as a tetraoxyanthrachinon, and that it was probably produced from hypogallic acid, $C^6H^3(OH)^2COOH$, in the same manner that rufigallic acid is formed from gallic acid. For this reason they gave it the name rufiopin.

According to the method of combining two molecules of oxybenzoic acid, with the loss of water, four oxyanthrachinons have been obtained thus far. This reaction is best explained by assuming anthrachinon to be a double keton, as has been mentioned under anthrachinon. According to their formation, the oxy groups in this class of oxy derivatives are equally divided among the two benzol rings, while in alizarin they are contained in one. The formulæ of the compounds named are therefore as follows:

$C^6H^3(OH <\begin{matrix}CO\\CO\end{matrix}> C^6H^3(OH)$, anthraflavon.

$C^6H^2(OH)^2 <\begin{matrix}CO\\CO\end{matrix}> C^6H^2(OH)^2$, anthrachryson and rufiopin.

$C^6H(OH)^3 <\begin{matrix}CO\\CO\end{matrix}> C^6H(OH)^3$, rufigallic acid.

None of these compounds is identical with any of those derived from the vegetable kingdom, nor with the oxy derivatives of anthrachinon derived from anthracene.

Oxyanthrachinons from Phthalic Acid and Oxybenzol Derivatives.

To these synthetical methods of production is to be added another which Baeyer recently discovered in the course of his beautiful investigation on the bodies derived from phthalic acid and the aromatic oxy compounds [Ber. Chem. Ges., 1871, 555 and 658].

558 When phthalic acid and hydrochinon are heated with sulphuric acid, a compound which is isomeric with and very similar to alizarin is formed along with other bodies; it has been examined by Grimm [Ber. Chem. Ges., 1873, 508], and described by him as chinizarin. It is formed after the following formula:

$$C^6H^4\begin{matrix}COOH\\COOH\end{matrix} + C^6H^4\begin{matrix}OH\\OH\end{matrix} = C^6H^4<\begin{matrix}CO\\CO\end{matrix}>C^6H^2\begin{matrix}OH\\OH\end{matrix} + 2H^2O$$

Phthalic acid. Hydrochinon. Chinizarin.

Like alizarin, it contains the two hydroxyl groups in the same ring. Mordanted cloth is difficultly dyed with this, and in different shades than by alizarin. It is most readily distinguished from alizarin by its absorption spectrum, its fusing point, and, above all, by the fluorescence of solutions in sulphuric acid or alcohol. This compound has also never been found in madder, and has never been prepared from anthracene.

According to a late observation of Baeyer and Caro [Ber. Chem. Ges., 1875, 152], chlorophenol, boiling at 218°, can be employed in place of hydrochinon in the preparation of chinizarin. The atom of chlorine is in this case replaced by hydrogen.

Since then Baeyer and Caro [Ber. Chem. Ges., 1874, 968] have succeeded in generalizing the above reaction. They have found that phenol and pyrocatechin, as well as hydrochinon on heating with phthalic acid and sulphuric acid, also give anthrachinon derivatives, if the reaction takes place at a high temperature, while at a low temperature pathaleines are formed. From phenol together with other products two oxyanthrachinons can be prepared, one of which is identical with the above, and the other isomeric, and named erythroxyanthrachinon by Baeyer and Caro, and which, like the other, also produces alizarin on fusing with caustic potash. Both oxyanthrachinons are prepared from phenol after the following formula:

$$C^6H^4\begin{matrix}COOH\\COOH\end{matrix} + C^6H^5OH = C^6H^4\begin{matrix}CO\\CO\end{matrix}C^6H^3(OH) + 2H^2O.$$

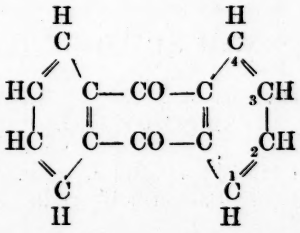
The same authors obtained from pyrocatechin and phthalic
559 acid a bioxyanthrachinon which is identical with alizarin from madder and from anthracene:

$$C_6H_4\begin{matrix}COOH\\COOH\end{matrix} + C_6H_4\begin{matrix}OH\\OH\end{matrix} = C_6H_4\begin{matrix}CO\\CO\end{matrix}C_6H_2(OH)_2 + 2H_2O.$$

Pyrocatechin.

While the older researches on alizarin and purpurin only showed that the hydroxyls are contained in the same ring, the investigations

of Baeyer and Caro also determine the exact positions of these hydroxyls. In alizarin it is the same as in pyrocatechin—that is, 1, 2; in chinizarin, corresponding to the hydrochinon, 1, 4; and in purpurin 1, 2, 4, since this is obtained from alizarin and chinizarin, as stated above. This is based on the following notation:



The third isomer, which contains two hydroxyl groups in one ring, is the xanthopurpurin found by Schützenberger and Schiffert [Bull. Soc. Chim. [2], iv, 12] in madder, and which, according to Schutzenberger, is produced by the reduction of purpurin and, according to Rosenstiehl [Compt. rend., lxxix, 764], is reconverted into purpurin by oxidation.

Transformation of oxyanthrachinons rich in oxygen into those which are poorer in oxygen.

These transformations are the reverse of the reactions previously mentioned, which by the oxidation of oxyanthrachinon produced alizarin and from this purpurine. The oldest known transformation of this kind is the conversion of purpurin into xanthopurpu-
560 rin by boiling an alkaline purpurin solution with tin salt (Schutzenberger). Liebermann, in connection with Troschke [Ber. Chem. Ges., 1875, 379] and Fischer [Ber. Chem. Ges., 1875, 975], has discovered another method. By acting on the coloring matters with ammonia at high temperatures amides are first formed, e. g., for alizarin:

$$C_{14}H_6\begin{cases} O_2 \\ (OH)_2 \end{cases} + NH_3 = H_2O + C_{14}H^6\begin{cases} O_2 \\ OH \\ NH_2 \end{cases}$$

Alizarinamide,

and for purpurin the reaction is analogous. By passing nitrous acid through the boiling alcoholic solution, the alizarinamide is converted into oxyanthrachinon, and the purpurinamide into xanthopurpurin, as follows:

$$C_{14}H_6\begin{cases}O_2\\OH\\NH_2\end{cases} + NO_2H + C_2H_6O = C_{14}H_7\begin{cases}O_2\\OH\end{cases} + N_2 + 2H_2O + C_2H_4O.$$

Aldehyde.

$$C_{14}H_5\begin{cases}O_2\\(OH)_2\\NH_2\end{cases} + NO_2H + C_2H_6O = C_{14}H_6\begin{cases}O_2\\(OH)_2\end{cases} + N_2 + 2H_2O + C_2H_4O.$$

Purpurinamide. Xanthopurpurin.

Lately Widmann [Bull. Soc. Chim., xxiv, 359] made the statement that he had obtained alizarin by reducing rufigallic acid with sodium amalgam.

Oxyanthrachinon from Chrysammic Acid.

The chrysammic acid which is obtained by treating the aloe with nitric acid had been considered by Gräbe and Liebermann to be tetranitrobioxyanthrachinon. Liebermann and Giesel [Ber. Chem. Ges., 1875, 1,643] produced it from bioxyanthrachinon by replacing the nitro groups by hydrogen. The following two reactions effect this change:

561 At first the chrysammic acid is converted into hydrochrysamide by boiling with potassium sulphide—

$$C_{14}H_2(NO_2)_4\begin{cases}O_2\\(OH)_2\end{cases} + 12H_2S = C_{14}H_2(NH_2)_4\begin{cases}O_2\\(HO)_2\end{cases} + 12S + 8H_2O$$

Chrysammic acid. Hydrochrysamide.

and then the hydrochrysamide is converted into the bioxyanthrachinon, called chrysazin by its discoverers, by the action of nitric acid and alcohol:

$$C_{14}H_2(NH_2)_4\begin{cases}O_2\\(OH)_2\end{cases} + 4NO_2H + 4C_2H_6O = C_{14}H_6\begin{cases}O_2\\(OH)_2\end{cases} + N_8 + 8H_2O + 4C_2H_4O$$

Chrysazin.

The chrysazin crystallizes in beautiful brown needles or in yellow scales, and does not color mordants.

On fusing chrysazin with potash, it takes up oxygen, and is converted into oxychrysazin $C_{14}H_8O_5$, which has the same composition as purpurin and dyes like it.

These scientific labors were here mentioned to give a complete picture of the results of the researches on alizarin and similar sub-

stances, and also on account of the interest which a knowledge of the whole group offers to those particularly concerned in the alizarin industry.

In connection with the foregoing chapter, it would seem proper to give a tabulated statement of the oxyanthrachinons derived from the vegetable kingdom and those prepared artificially.

Besides these, there are two analogous coloring matters, known derivatives of methylanthracen (which is very closely related to anthracene).

Chrysophanic acid.	Emodin.
$C_{14}H_5(CH_3)O_2(OH)_2$	$C_{14}H_4(CH_3)O_2(OH)_3$

—which occur in the root of the rhubarb. Their relations to the group just considered have been shown by Graebe and
563 Liebermann, and by the latter alone [Ber. Chem. Ges., 1875, 975] and by him and Fischer [Ber. Chem. Ges., 1875, 1,103].

A glance at the table will also show how productive to science the proof was that alizarin is to be considered a bioxyanthrachinon. In the same we see that until now nine oxyanthrachinons have been obtained from the vegetable kingdom, and thirteen have been artificially prepared. Of all these compounds, the identity of two of the vegetable kingdom with two which are artificially prepared has been fixed, and these are the longest known compounds—alizarin and purpurin. The xanthopurpurin might also be added, since it can be prepared from purpurin, that is, artificially.

As a new coloring matter, only isopurpurin has come into use by the manufacture of alizarin, and that has so far only been employed in a mixture with alizarin.

With the close of 1869, the alizarin industry entered a state in which it could be considered a promising industry. In 1870 it became a paying branch of industry, and since then it has constantly increased. As far as can be judged, the amount of production was as follows:

1871*	125,000	to	150,000	kgs.	alizarin	of 10	per cent.
1872	400,000	"	500,000	"	"	"	"
1873**	900,000	"	1,000,000	"	"	"	"

The production of 1873 represents a value of ten to twelve million marks. Since then it has increased, and at present (1875) the daily production is estimated at 15,000 kg. of 10 per cent. paste. The most and largest works are in Germany; a few are in England, France, Switzerland, Austria, and Russia.

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*Gessert Bros., in a communication to the Mullhouse Industrial Society, informed them, on November 1, 1871, that up to that date they had manufactured 30.792 kgs. alizarin paste representing a value of half a million marks. At that time they made 6.000 kgs. 10 per cent. alizarin per month.

** Wiener Weltausstellung. Amtlicher Katalog der Ausstellung des deutschen Reiches, 109.

	$C_{14}H_7O_2 \cdot OH$.	$C_{14}H_6O_2(OH)_2$	$C_{14}H_5O_2(OH)_3$	$C_{14}H_4O_2(OH)_4$	$C_{14}H_2O_2(OH)_6$.
From Madder		Alizarin. Xanthopurpurin. Isoalizarin.	Purpurin.	Pseudo-purpurin.	
From other plants		Frangulic acid. Morindon (?)	Purpurin.		
From Anthracene	Oxyanthrachinon.	Alizarin. Anthraflavic acid.	Isopurpurin. Purpurin (indirect).		
From Oxybenzoic Acids		Anthraflavon.		Anthrachryson Rufiopin.	Rufigallic acid.
From Phthalic Acid	Erythroxyanthrachinon. Oxyanthrachinon.	Chinizarin. Alizarin.	Purpurin (indirect).		
From Chrysammic Acid		Chrysazin.	Oxychrysazin.		

564 As the manufacture increased the sources from which anthracene could be obtained also became more numerous. The isolation of this hydrocarbon pays at its present comparatively high price, and therefore a larger production can yet be supplied with material.

The amount of alizarin manufactured in 1873 does not quite cover one-fifth of the amount of madder color needed, which is estimated at 50,000,000 kg. roots, with 1 to 1½ per cent. of coloring matter, valued at about 45,000,000 marks. At present there is produced annually about the same amount of alizarine artificially as was formerly obtained in a year's harvest of madder. By the competition of the artificial coloring matter the price of madder has fallen one-half since 1871, and the cultivation in and export from France has considerably diminished. [E. Kopp (Mon. Scient., 1875, 487) states that the madder cultivated in 1874 is two-thirds less than that of the previous year.] The firm of Thomas Fréres, in Avignon, formerly renowned for their garancine, have already entered into connection with the Baden Anilin and Soda Works for the manufacture of artificial alizarin.

Per contra, in the department of the Rhône, where madder covers more than 20,000 hectares, voices have been raised which urge the more careful cultivation of the plant, in order to produce a larger amount of coloring matter. [Besse et Rieu, Essais d'amélioration de la culture de la garance, mémoire presenté à la Chambre de Commerce d'Avignon et à la Societé d'Agriculture de Vaucluse, 20 Jan., 1875.] Experiments to this effect have already been made at Avignon, and it seems that a rational manuring and choice of seed promises success. [Monit. Scient., 1875, 486.] The manufacturers of madder extracts have also made new exertions to produce an article which can compete with artificial alizarin. On the other hand, the price of artificial alizarin has also fallen from 20 marks per kg. in 1870 to 8 marks at present, and even to 5 to 6 marks for violet sorts.

Comparatively little difficulty was encountered in introducing artificial alizarin into practical dyeing, because it was offered to the dyers and printers in a form in which they were familiar with
565 the madder extract of Perrod and of Meissonier, employed for direct printing. By the artificial alizarin, important progress has been made both in dyeing and printing, because the simultaneous application of the same in conjunction with other coloring matters by means of topical printing essentially simplifies the production of colored calicos, and at the same time permits the production of varieties which excel in the beauty and fastness of the colors.

Greater difficulties were met in the Turkey-red dyeing, but they were finally overcome, as shown at the Vienna Exposition; and the artificial product has led to improvements, by means of which the goods can be brought much more rapidly into commerce.

A not unimportant change has been experienced in the ordinary

method of madder and garancine dyeing, by the employment of artificial coloring matter. While it formerly required one and a half to three hours, and careful observation of the rising temperature in the bath, it now only requires a few minutes near the boiling temperature to dye with artificial alizarin. This permits the dyeing to go on continuously, piece sewed to piece, saving a great deal of space and steam. The madder dyeing, which required much skill in determining the amount of coloring materials contained in the madder, as well as on account of the influence of certain vegetable matters, is now replaced by a very simple method.

The artificial alizarin, as its price falls, will more and more limit the employment of dyewoods which are used as substitutes for madder, and will cause more beautiful and specially faster-dyed goods to be brought into the market.

Artificial alizarin was exhibited at Vienna by—

Germany—Baden Anilin and Soda Works, Ludwigshafen on the Rhine.
J. Bronner, Frankfurt on the Main.
Gessert Bros., Elberfeld.
Meister, Lucius & Bruning, Hoechst on the Main.
Weiler & Co., Cologne.

566 France—Thomas Freres, Fabrique d'Alizarin Artificielle, Nouvelle sur Saoune.

Switzerland—J. R. Geigy, Basel.

United States Patent of Caro and Graebe and Liebermann.

Heinrich Caro, of Mannheim, grand duchy of Baden, and Charles Graebe and Charles Liebermann, of Berlin, Prussia.

Improvement in the preparation of coloring matters from anthracene.

Specification forming part of letters patent No. 154.536, dated July 28, 1874; application filed January 26, 1870.

To all whom it may concern:

Be it known that we, Heinrich Caro, of Mannheim, in the grand duchy of Baden, and Charles Graebe and Charles Liebermann, both of Berlin, in the kingdom of Prussia, have invented certain new and useful improvements in preparing coloring matters, of which the following is a specification.

This invention relates to improvements on an invention described in letters patent of the United States granted to Charles Liebermann and Charles Graebe for improvements in preparing coloring matters, dated the 5th day of October, 1869, No. 95465, in which the preparation of artificial alizarine is based upon the action of caustic alkalies upon bibrom-anthrakinon or bichlo-ranthrakinon.

We have now discovered that a similar result may be obtained by substituting sulphuric acid for bromine or chlorine in the
567 above process We thus obtain the sulpho-acids of anthrakinon, which by being dissolved in and heated with an excess of caustic alkali are converted into alizarine. This invention relates to improvements in the production of coloring matters and more especially to improvements in the methods of producing what is known as artificial alizarine from anthracene—a method of producing which was described in the above named letters patent, and consisted in the production of artificial alizarene by converting anthracene into either bibrom-anthrakinon or bichlo-ranthrakinon, and then acting upon the same by means of an alkali and precipitating the alizarine contained in the alkaline solution by means of an acid.

In the complete specification of the aforesaid letters patent granted to Charles Liebermann and Charles Graebe two different series of processes are described for obtaining the brominated or chlorinated derivatives of anthrakinon.

In the first of these processes the anthracene is submitted to the action of oxidizing agents as is well understood, and the oxidized anthracene or anthrakinon is then treated with bromine or chlorine.

In the second of these processes the anthracene is first treated with bromine or chlorine and subsequently submitted to an oxidizing process in order that the desired compounds, *videlicet*, bibromanthrakinon or bichlo-ranthrakinon may be obtained.

In an analogous manner we now employ sulphuric acid as a substitute for the bromine or chlorine employed in the processes above referred to, and we thus obtain the sulphuric acid derivatives of anthrakinon, which we call "the sulpho-acids of anthrakinon."

Our invention is carried into effect by means of either of the two processes, which we will proceed to describe.

In the one process we proceed as follows: We take about one part by weight of anthrakinon, and about three parts by weight of sulphuric acid of about the specific gravity of 1.840 and introduce the same into a retort, which may be made of glass or of porcelain,
or of other material not easily acted upon by sulphuric acid,
568 and the contents are then to be heated up to about 260° centigrade, and the temperature is maintained until the mixture is found no longer to contain any appreciable quantity of unaltered anthrakinon. The completion of this desired operation may be ascertained or tested by withdrawing a small portion of the product from time to time, and continuing the operation at the high temperature until such product upon being diluted with water is found to form a substantially perfect solution, thereby indicating that the anthrakinon has become either entirely or in greater part converted into the desired product. The results of this operation are then allowed to cool and are diluted with water. We then add carbonate of lime in order to neutralize and remove the excess of sulphuric acid contained in the solution, The mixture is then filtered, and to the filtrate carbonate of potash or carbonate of soda by preference

in solution is to be added until carbonate of lime is no longer precipitated. The mixture is then filtered and the clear solution is evaporated to dryness, by which means the potash or soda-salts of what we call the "sulpho-acids of anthrakinon" are obtained, and which are to be treated in the following manner: We take about one part by weight of this product and from two to three parts by weight of solid caustic soda or potash. Water may be added or not, but by preference we add as much water as is necessary to dissolve the alkali. After admixture we heat the whole in a suitable vessel, and the heating operation is continued at a temperature of from about 180° to about 260° centigrade for about one hour, or until a portion of the mixture is found, upon withdrawing and testing it, to give a solution in water, which being acidulated with an acid—for example, sulphuric acid—will give a copious precipitate of the coloring matters. The heating operation having been found to have been continued for a sufficient time, the resulting products are then dissolved in water, and we either filter or decant the solution of the same, from which we precipitate the coloring matters or artificial alizarine by means of a mineral or organic acid, such, for example, as sulphuric or acetic acid. The precipitated coloring matters thus
569 obtained are collected on a filter or otherwise, and after having been washed may be employed for the purposes of dyeing and printing, either in the same way as preparations of madder are now used or otherwise.

In carrying out our other process we proceed as follows: We take about one part, by weight, of anthracene, and about four parts, by weight, of sulphuric acid of specific gravity of about 1.848, and the mixture, being contained in a suitable vessel, is heated to a temperature of about 100° centigrade, at which temperature it is to be maintained for the space of about three hours. The temperature is then to be raised to about 150° centigrade, which temperature is to be maintained for about an hour, or until a small portion of the product, when submitted to the subsequent processes hereinafter described, is found to produce the desired coloring matters. We then allow the result obtained by this operation to cool and dilute it with water, by preference in the proportion of about three times its weight. To the solution thus obtained we add, for every part of anthracene, by weight, which had been employed in the previous operation, about from two to three parts, by weight, of peroxide of manganese, preferring to employ an excess, and we boil the whole strongly for some time; and, in order to fully insure the desired degree of oxidation, the mixture may be subsequently concentrated, and, by preference, be evaporated to dryness, and the heat be continued until a small portion of the oxidized product, when submitted to the subsequent processes hereinafter described, will produce the desired coloring matters. We then neutralize and remove the sulphuric acid contained in this mixture, and at the same time precipitate any oxide of manganese which may be held in solution, by adding an excess of caustic lime, which we use, by preference, in the form of milk of lime, and

we add the same until the mixture has an alkaline reaction. We then filter and add to the filtrate carbonate of potash or soda until there is no further precipitation of carbonate of lime. The solution is then filtered and evaporated to dryness; and we thus obtain the potash or soda-salts of what we call "the sulpho-acids of anthrakinon."

570 In effecting the conversion of the oxidized products thus obtained into coloring matters, or into what we call "artificial alizarine," we proceed as follows: We take one part, by weight, of this product, and from two to three parts, by wieght, of solid caustic soda or potash, and water may be added or not; but, by preference, we add as much water as is necessary to dissolve the alkali. After admixture we heat the whole in a suitable vessel, and continue the heating operation, at a temperature from about 180° to about 260° centigrade, for about one hour, or until a portion of the mixture is found to give solution in water, which, upon acidulation with an acid—for example, sulphuric acid—is found to give a copious precipitate of the coloring matters. The heating operation having been found to have been continued for a sufficient time, we then dissolve the product in water, and either filter or decant the solution of the same, from which we precipitate the coloring matters or artificial alizarine by means of a mineral or organic acid—such, for example, as sulphuric or acetic acid. The precipitated coloring matters thus obtained are collected on a filter or otherwise, and, after having been washed, may be employed for the purpose of dyeing and printing, either in the same way as preparations of madder are now used or otherwise.

Instead of acting upon anthracene by means of sulphuric acid of the density before mentioned, fuming sulphuric acid may be employed; but we prefer to use the ordinary acid, as before described.

In order to effect the process of oxidation before referred to, other oxidizing agents may be used in place of the peroxide of manganese before mentioned—such, for example, as peroxide of lead; or chromic, nitric, or other acids capable of effecting the desired oxidation may be employed. If the oxidizing agent be a soluble one—such, for instance, as chromic acid—any excess of the oxidizing agent that may have been employed should be removed or reduced before proceeding with the subsequent operation. Thus, for example, had chromic acid been used in excess, sulphurous acid may be passed through the product before adding the lime. In the case of the

571 employment of nitric acid the oxidized mixture should be heated until the greater proportion of the nitric acid has been evaporated, and until the sulphuric acid has become so concentrated that it commences to volatilize.

Although we have mentioned the employment of carbonate of lime and of caustic lime for the purpose of effecting the neutralization of the sulphuric acid existing in the solution of the products obtained from the treatment of anthrakinon, and from anthracene, as hereinbefore described, it will be understood that other bases which will neutralize the acid, and which will not in any way be in-

jurious in any of the subsequent processes, may be substituted for the same.

Having now described our invention, and methods we employ in carrying it into effect, we claim—

1. The manufacture of coloring matters by submitting anthrakinon to the action of sulphuric acid, so as to obtain soluble compounds, which we have called "sulpho acids of anthrakinon," treating the products of such operation with an alkali, and precipitating the coloring matters therefrom by means of an acid, as herein described.

2. The manufacture of coloring matters by submitting anthracene to the action of sulphuric acid, oxidizing the product thereby obtained, heating such oxidized product with an alkali, and subsequently precipitating the coloring matters therefrom by means of an acid, as herein described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HEINRICH CARO.
CHARLES GRAEBE.
CHARLES LIEBERMANN.

Witnesses to the signature of Heinrich Caro and Charles Graebe:

J. HENRY JOHNSON.
THOS. A. BYRNE,
Clerk to J. Henry Johnson.

Witnesses to the signature of Charles Liebermann:

H. KREISMANN.
HERMAN ZUNGE.

572 In the Circuit Court of the United States, southern district of New York.—In Equity.

To the honorable the judges of the Circuit Court of the United States for the southern district of New York:

Badische Anilin and Soda Fabrik, a corporation organized under the laws of the Grand Duchy of Baden, in the Empire of Germany, and doing business at Manheim and Ludwigshafen, in said Empire of Germany, bring this their bill of complaint against James Higgin and Abraham Lloyd, John O'Rourke and John Simpson, defendants, the said James Higgin and Abraham Lloyd doing business under the name and style of James Higgin & Co., at Providence, Rhode Island, but, as complainants are informed and believe, residing in Great Britain, and the said John O'Rourke and John Simpson, residing at said Providence, and being and acting as agents of the said firm of James Higgin & Co.

And thereupon your orators, upon information and belief, complain and say, that heretofore and before the fifth day of October,

1869, Charles Graebe of Frankfort-on-the-Main, being then a citizen of the United States, and Charles Lieberman of Berlin, Prussia, being then a citizen of Prussia, were jointly the first and original inventors and discoverers of a certain new and useful improvement entitled "Process for Preparing Alizarine," described in the letters patent, dated October 5th, 1869, hereinafter mentioned, and which was not known or used by others prior to their invention thereof, and which was not, and had not been at the time of their application for letters patent therefor, as hereinafter mentioned, in public use or on sale with their consent and allowance, contrary to the provisions of the statutes of the United States in such case made and provided.

That they, being so as aforesaid the first and original inventors and discoverers of the said improvement, and being desirous to obtain an exclusive property in said invention or improvement, within and for the United States, did, on the fifth day of October, 1869, upon due application therefor, and having in all things complied with the conditions and requirements of the acts of Congress in such case made and provided, obtain letters patent of the
573 United States for said invention or improvement, in due form of law, under the seal of the patent office of the United States, signed by the secretary of the interior, and countersigned by the commissioner of patents, bearing date the said fifth day of October, 1869, and numbered 95,465, which said letters patent are now remaining of record in the patent office of the United States, by which said letters patent there was granted and secured, or intended to be granted and secured, to them, their executors, administrators or assigns, for the term of seventeen years from the said fifth day of October, 1869, the full and exclusive right and liberty of making, using, and vending to others to be used, the said invention or improvement described in said letters patent, and by virtue thereof they became and were the sole owners of all the rights and privileges granted and secured, or intended to be granted and secured, in and by said letters patent.

And your orators further show unto your honors that the said Charles Graebe and Charles Liebermann having for good and lawful cause, after the issuing of the said letters patent as aforesaid, surrendered the same to the commissioner of patents, and having made due application therefor, and having in all things complied with the requirements and conditions of the acts of Congress in such case made and provided, did, on the fourth day of April, 1871, obtain new letters patent, numbered 4321 of reissued letters patent, for a distinct and separate part of the same invention, on a corrected specification, for the residue of the said term of seventeen years from the fifth day of October, 1869, which said reissued letters patent were issued in due form of law, under the seal of the patent office of the United States, signed by the acting secretary of the interior, and countersigned by the commissioner of patents, bearing date the said fourth day of April, 1871, and numbered

4321 of reissued letters patent, and which said reissued letters patent No. 4321 are now remaining of record in the patent office of the United States, as by said letters patent No. 4321, or a duly authenticated copy thereof, in court ready to be produced, will fully and at large appear.

And your orators further show unto your honors, that afterwards, and on or about the first day of March, 1872, the said Charles Graebe and Charles Lieberman did, by an assignment in writing, duly signed, executed and delivered, and bearing date the first day of March, 1872, sell, assign, and transfer unto your orators, along with other things, all their, the said Graebe and Liebermann's. rights, title, and interest in and to said letters patent, reissue No. 4321, so as aforesaid granted to them, and in the invention described therein, and secured, or intended to be secured thereby, which said assignment was duly recorded in the patent office of the United States, on the twenty-eighth day of March, 1872, in liber 1^{15} of transfers of patents, page 260, as by said assignment, or a duly authenticated copy thereof, together
574 with the certificate of the recording thereof, here in court ready to be produced, will fully and at large appear, and by virtue of which assignment your orators became and are the sole owners of all rights and privileges granted and secured, or intended to be granted and secured in and by said letters patent so granted as aforesaid, on the said fourth day of April, 1871.

And your orators further show that by reason of the premises your orators have been ever since the said first day of March, 1872, and are exclusively entitled to use, exercise, and enjoy all the exclusive rights, privileges, profits, and advantages granted and secured, or intended to be granted and secured, in and by said reissued letters patent, No. 4321, for and during the term of years in said reissued letters patent mentioned.

And your orators further show unto your honors that the said invention or discovery so patented as aforesaid and assigned unto your orators is very valuable and useful to the public, and that the same has been extensively introduced into public use, and that the public have generally acquiesced in your orators' exclusive right to the same, and your orators would, but for the wrongful acts of the said defendants, and others acting in concert with them, have made large gains and profits from the manufacture, use, and sale of the said invention, which they have been and are now hindered from making by reason of said wrongful acts of the said defendants.

And your orators further show unto your honors, upon information and belief, that the said defendants, James Higgin, Abraham Lloyd, John O'Rourke, and John Simpson, well knowing the premises, and the rights and privileges secured unto your orators, and in order to deprive them of the profits, benefits, and advantages which might and otherwise would have accrued to them, at the city of Providence and elsewhere, and within the district of Rhode Island, and without the license or permission of your orators, have

ever since the first day of March, 1872, and at divers times since that time, and before the commencement of this suit, unlawfully and wrongly made and caused to be made, sold and caused to be sold, used and caused to be used, said invention, and dyes or coloring matter containing the said invention or discovery and improvements, or substantial or material parts thereof, described and patented in the said the reissued letters patent number 4321, the exclusive right to which is secured to your orators, as hereinbefore set forth, and which said unlawful making, use, and sale by the defendants as aforesaid, are a violation and infringement of your orator's rights and privileges, under the said reissued letters patent as aforesaid, and that the said defendants still continue so to do, in defiance of your orators' said rights and privileges, and to your orators' great and irreparable loss and injury, and by which your orators have sustained and been put to great loss and damage,

575 and have been and still are deprived of great gains and profits, which your orators might, and otherwise would have obtained and received, but which have been received and enjoyed and are being received and enjoyed by the said defendants by and through their aforesaid unlawful acts and doings; and that the said defendants have derived and received, and are still deriving and receiving from such use, great gains and profits, but to what amount your orators are ignorant and cannot set forth, but your orators believe the same to be about the full sum of ten thousand dollars, and so charge the fact to be, and pray that the said defendants may be required to make a discovery as to their use of said invention, and of all gains and profits received by them therefrom or by means thereof.

And your orators further show unto your honors that the aforesaid using of said invention by the said defendants and their confederates, and their preparation and determination to continue the same, and the aforesaid unlawful and wrongful acts have the effect to encourage and induce other persons to infringe and defy the letters patent as aforesaid, and the aforesaid exclusive rights and privileges of your orators.

And your orators furthur show unto your honors that the said defendants have been warned and requested and notified to desist and refrain from said infringement and said unlawful and wrongful acts, but that said warning and request and notice have been wholly disregarded by said defendants, and that said defendants still continue the infringement and unlawful and wrongful acts aforesaid.

And your orators pray that the said defendants may be compelled, by a decree of this honorable court, to account for and pay over unto your orators all such gains and profits as have accrued or arisen to, or have been earned or received by the said defendants, and all damages your orators have sustained by reason of the said infringements by the said defendants.

And that the said defendants, James Higgin, Abraham Lloyd,

John O'Rourke, and John Simpson, their and each of their agents, attorneys, servants, and workmen, be enjoined and restrained by the order and injunction of this court from directly or indirectly making or causing to be made, using or causing to be used, or vending to others to be used, said invention, in any manner, or any dyes or coloring matter containing or embodying or in any way counterfeiting or imitating the said invention described and secured in said letters patent so granted as aforesaid, No. 4321, and from infringing upon or violating the said letters patent, by the use or sale of the said invention or of said dyes or coloring matter in any way whatever, and that all such infringing dyes or coloring matter in the possession of said defendants may be forthwith destroyed or delivered up to your orators, and that the said defendants may be decreed to pay the costs of this suit, and that your orators may have such other or further order or relief as to this honorable court shall seem meet and shall be agreeable to equity.

576 To the end therefore that the said defendants, James Higgin, Abraham Lloyd, John O'Rourke, and John Simpson may, if they can, show why your orators should not have the relief hereby prayed, and may upon their several corporal oaths true and direct and perfect answer make according to the best of their or their agents, clerks, servants, and workmen's knowledge, remembrance, information, and belief, to the several matters hereinbefore averred and set forth, as fully and particularly as if the same were here repeated, paragraph by paragraph, and they thereto severally and specifically interrogated.

May it please your honors to grant to your orators a writ of *subpœna ad respondendum*, issuing out of and under the seal of this honorable court, directed to the said defendants, James Higgin, Abraham Lloyd, John O'Rourke, and John Simpson, commanding them and each of them, by a certain day, and under a certain penalty, to be and appear in this honorable court, then and there to make answer unto this bill of complaint, and to perform and abide by such order and decree herein as to this court may seem meet and agreeable to equity.

And your orators will ever pray, &c.

(Signed) BADISCHE ANILIN AND SODA FABRIK,
By WM. PICKHARDT, *Att'y.*

J. VAN SANTVOORD,
Comp's Sol'r and of Counsel.

UNITED STATES OF AMERICA,
City and County of New York, } *ss.*
Southern District of New York,

WILHELM PICKHART, the attorney in fact of the complainants in the foregoing complaint named, being duly sworn, deposes and says that he has read the foregoing bill of complaint by him subscribed as such attorney, and knows the contents thereof, and that

the same are true of his own knowledge, except as to those matters therein stated on information and belief, and as to those matters he believes it to be true. And he further deposes and says that he verily believes that the said Charles Graebe and Charles Liebermann are the first and original inventors or discoverers of the invention or improvement patented to them, as set forth in said bill of complaint, and that the same has not, to the best of his knowledge, information, and belief, been in use, or been described before the invention thereof by said Graebe and Liebermann; and deponent further says that his information is derived in part from his correspondence with the said complainants, who carry on business in Germany, and from his own business transactions and
577 those of his firm, William Pickhardt & Kuttroff, of said city of New York, with complainants; and further, that deponent has been appointed by the said complainants, and now is their true and lawful attorney, with power to sue persons infringing said reissued patent in said bill mentioned.

WM. PICKHARDT.

Subscribed and sworn to before me this 7th day of October, 1874.

[L. S.] W. HAUFF, (146,)
Notary Public, N. Y. City and County.

(Copy.)

United States Circuit Court, southern district of New York.

THE BADISCHE ANILIN AND SODA FABRIK *vs.* JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE, and JOHN SIMPSON. } In Equity.

To the honorable the judges of the Circuit Court of the United States within and for the southern district of New York:

The joint and several answer of James Higgin, Abraham Lloyd, John O'Rourke, and John Simpson, defendants, to the bill of complaint of the Badische Anilin and Soda Fabrik, complainants.

The defendants, now and at all times hereafter saving and reserving to themselves all benefit and advantage of exception which can or may be taken to the many errors, uncertainties, and other imperfections in the said orators' bill of complaint contained, for answer thereunto, or unto so much thereof as the defendants are advised is material or necessary for them to make answer unto, these defendants, answering, say—

They are informed, and believe it to be true, that one Charles Liebermann and one Charles Graebe, pretending to be the original joint and first inventors and discoverers of a certain new improvement entitled "Process for Preparing Alizarine," did, on the fifth day of October, 1869, upon application therefor, obtain let-
578 ters patent of the United States for said supposed invention under the seal of the patent office of the United States,

signed by the secretary of the interior and countersigned by the commissioner of patents, bearing date the said fifth day of October, 1869, purporting to grant and secure to the said Graebe and Liebermann, their heirs, administrators, or assigns, for the term of seventeen years from and after the date of said patent, the full and exclusive right and liberty of making, using, and vending to others to be used, the said supposed and pretended invention and improvement as is in the orators' bill fully set forth ; but for the certainty thereof they pray that the orators may be required to make proof of the same.

And these defendants, further answering, say that as to whether or not the said Charles Graebe and the said Charles Liebermann were citizens of the United States and Prussia, respectively, as stated in said bill, they are ignorant, so that they can neither admit or deny, but leave the orators to prove the same.

But these defendants deny that the said Charles Graebe and Charles Liebermann were or are the original joint and first inventors of the said supposed new and useful improvement, and that the same had not been known or used before their supposed invention thereof, and that the same was not, at the time of making application for said letters patent, in public use and on sale with their consent and allowance; and that, by virtue of said letters patent, the said Graebe and Liebermann became and were the sole owners of all or of any of the rights and privileges which purport to have been secured and granted thereby. And these defendants, further answering on information and belief, say that it is not true that the said Charles Graebe and Charles Liebermann were at any time or in manner the joint inventors or discoverers of the alleged improvements, or of any or either of them, or of any part thereof described and claimed in the said joint letters patent, dated the fifth day of October, 1869, or in the reissue thereof, hereinafter mentioned, as stated in said bill; but that, on the contrary thereof, they did not together make the invention described in said patent and reissue, but that each was (if an inventor of anything described or claimed therein) the sole and individual inventor or discoverer of the entire thing described in said patent and reissue, separately and independently of the other, and not jointly ; and, by reason of the premises, said Charles Graebe and Charles Liebermann, could not lawfully obtain jointly such letters patent for things which they did not jointly invent or discover, and that the said letters patent, dated the fifth day of October, 1869, and the reissue thereof, were not granted according to law, and that by reason of the premises the said letters patent, dated the fifth day of October, 1869, were, and the reissue thereof is, wholly null and void.

These defendants, further answering, say that they have
579 been informed, and believe it to be true, that said Charles Graebe and Charles Liebermann surrendered said letters patent to the commissioner of patents, and having made application therefor, did, on the fourth day of April, 1871, obtain new

letters patent, purporting to be for the same invention, for the residue of said term of seventeen years from the fourth day of April, 1871, which were issued under the seal of the patent office of the United States, signed by the acting secretary of the interior and countersigned by the commissioner of patents, and bearing date the fourth day of April, 1871; but for the certainty thereof they pray that the orators may be required to make proof of the same.

And the defendants, further answering on information and belief, say that said reissued patent is broader than the alleged invention of said Graebe and Liebermann, and covers more than was described or made known in their original patent, or in their application therefor, and more than was represented in the specimens deposited in the patent office on their application for said original patent, and that said reissue is not for the same invention as was said original patent. And the defendants, further answering, say that as to whether or not said reissued letters patent were assigned to the orators, as set forth in said bill, they are ignorant, so that they can neither admit or deny, but leave the orators to prove the same.

And the defendants, further answering, say that they deny that the orators ever became or are now the sole and exclusive legal owners of the alleged invention, or of the rights and privileges, or any of them, supposed and pretended to be granted and secured by said letters patent and reissue.

And the defendants, further answering, say that as to whether or not said alleged invention or discovery has been introduced into public use, as stated in said bill, your orators are ignorant, so that they can neither admit nor deny, but leave the orators to prove the same. But they deny that the said alleged invention is very valuable, or of any value or useful to the public, or that the public have generally acquiesced in the orators' pretended rights to the same, as stated in said bill, or that the orators would in any manner have made large or any gains or profits from the manufacture, use, or sale of said alleged invention; and these defendants deny that they ever have been or are now hindering the orators in any way.

And these defendants, further answering, deny that ever since the first day of March, 1872, or at divers times since that time, or before the commencement of this suit, or at any other time, they, well knowing the premises or the rights or privileges pretended to be secured to the orators, or in order to deprive the orators of any profits, benefits, or advantages which might or otherwise would have accrued to the orators at the city of Providence, or else-
580 where within the district of Rhode Island, unlawfully or wrongfully made or caused to be made, or sold or caused to be sold, or used or caused to be used, the said alleged invention, or any dyes or coloring matter containing the said alleged invention or discovery or improvements, or any substantial or material parts thereof, described or patented in the said reissued letters patent No.

4321, which the said orators allege to be a violation or infringement of the orators' pretended rights or privileges.

And these defendants deny that any of their acts and doings are to the great or any loss or injury of the orators, or deprive them of great or any gains or profits which the orators might in any way have received, obtained, or enjoyed; and they also deny that they have received or enjoyed, or are receiving or enjoying, any gains or profits from any unlawful acts or doings, as alleged in said bill; and they deny that any of their acts or doings have the effect to encourage and induce other persons to infringe or defy the said reissued letters patent, or the pretended rights of the orators.

And these defendants, further answering, deny that they have derived or received, or are still deriving or receiving, from the alleged wrongful making, using, and selling of the said pretended invention, large or any gains or profits.

And these defendants, further answering, say that the process described in the orators' patent, granted to Graebe and Liebermann, and the reissue thereof numbered 4321, is not so full, clear, and exact that one skilled in the art to which it relates could produce or construct the dye or coloring matter purporting to be described in and secured by said letters patent and reissue; but to the contrary, said description and claim thereof are obscure and ambiguous, and the said reissued letters patent are therefor void.

And these defendants, further answering, say that the said Charles Graebe and Charles Liebermann were not the original, joint, and first inventors of the things patented in the patent and reissue granted and alleged to be assigned to the orators, but that alizarine was known and publicly used for more than two years before the alleged invention by the said Graebe and Liebermann in the United States, and that the same was produced artificially in the year 1826 by M. M. Robiquet and Colin at the city of Paris, in France, and by M. Kuhlmann at the city of Lille, in France, and that their discovery was known, and it and the process concerning the same were published and fully described by Francis Ure in his *Dictionary of Arts and Science*, published at London, in England, by Longman, Green & Company, in Paternoster row, in the year 18—, in volume —— of the same, page ——, and also the reprint of the same work by D. Apppleton & Company, of New York city, state of New York, vol. 1, page 88. And that the substantial and
581 material parts of said alleged invention of Graebe and Liebermann were also known to and publicly used in the United States and Europe long prior to the said alleged invention, by William H. Perkin, at Sudbury, in the county of Middlesex, in England, to whom letters patent of the kingdom of Great Britain were granted on the 25th day of June, 1869, for an improvement in coloring matters, and numbered 1948. Each of the said persons, and many others, had such prior knowledge of said alleged invention, and publicly used and sold the same at the places above recited.

And these defendants, further answering, say that they deny that

they have manufactured or sold alizarine in the United States made in, under, or in accordance with the reissued letters patent No. 4321, dated April 4, 1871; but to the contrary thereof, these defendants have sold alizarine within the United States, which they, in the course of their business, have imported from London, England, and which said alizarine was produced by a process patented in England to William Meister, Dr. Eugene Lucius, and Dr. Adolph Bruning on the sixth day of September, 1872, and numbered 2649, and which, as these defendants are advised and believe, is wholly different in every particular from the process described in the said reissued letters patent No. 4321, and dated April 4, 1871.

And the defendants, further answering, say, on information and belief, that the said invention and improvement patented in and by said patent and the reissue thereof, and substantial and material parts thereof claimed as new, had been in open and public use and on sale with the consent and allowance of the said Charles Graebe and Charles Liebermann for more than two years prior to the application of said Graebe and Liebermann for a patent, and that the persons above named, and many other persons, possessed such prior knowledge of the things patented in and by said letters patent and reissue, and publicly used and sold the same at the place above recited.

And these defendants pray the same advantage of their aforesaid answer as if they had pleaded or demurred to the said bill of complaint; and these defendants pray leave to be hence dismissed with their reasonable costs and charges in this behalf most wrongfully sustained.

JOHN O'ROURKE,
JOHN SIMPSON,
JAMES HIGGIN,
ABRAHAM LLOYD.
By JOHN SIMPSON, *Att'y.*

ARNOUX, RITCH & WOODWARD,
Solicitors and of Counsel for Deft's.

582 UNITED STATES OF AMERICA,
District of Rhode Island, City of Providence, } *ss.*

On this ninth day of February, 1875, before me personally appeared John O'Rourke and John Simpson, two of the defendants in the above-entitled suit, who, being duly sworn, depose and say that they have read the foregoing answer and know the contents thereof, and that the same is true of their own knowledge, except as to those matters which are therein stated on information and belief, and as to those matters they believe it to be true. And the said John Simpson further says that he had signed the foregoing answer for James Higgin and Abraham Lloyd, the other two of said defendants, who are absent from this country, to wit, in the kingdom of Great Britain, and that he has so signed the same as

their agent and attorney in this country, and that as such attorney and agent he has full knowledge of all the facts concerning the premises, and that his knowledge is derived from admissions made to him by said James Higgin and Abraham Lloyd.

[L. S.] J. G. MARKLAND,
Notary Public.

Complainant's Exhibit A.—R. E. S., examiner, &c.

The U. S. Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissued letters patent granted Graebe and Liebermann, dated April 4th, 1871, No. 4321, for "Improvement in Dyes or Coloring Matter from Anthracine."

In testimony whereof I, Ellis Spear, acting commissioner of patents, have caused the seal of the patent office to be hereunto affixed, this fifteenth day of May, in the year of our Lord one thousand eight hundred and seventy-five, and of the independence of the United States the ninety-ninth.

[L. S.] ELLIS SPEAR,
Acting Commissioner.

583 No. 4321. Reissue.

The United States of America.

To all to whom these letters patent shall come:

Whereas Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia, have alleged that they have invented a new and useful improvement in dyes or coloring matter from anthracine (for which letters patent were issued to them, dated October 5, 1869, which letters having been surrendered, the same have been canceled, and new letters ordered to issue to them on two separate amended specifications,) and have made oath, the said Graebe, that he is a citizen of the United States, and the said Liebermann that he is a citizen of the kingdom of Prussia; that they verily believe they are the original and first inventors or discoverers of the said improvement, and that the same hath not to their knowledge and belief been previously known or used; have paid into the treasury of the United States the sum of thirty dollars, and presented a petition to the commissioner of patents praying that a patent may be issued therefor—

These are therefore to grant to the said Graebe and Liebermann, their executors, administrators, or assigns, for the term of seventeen years from the fifth day of October, one thousand eight hundred and sixty-nine, the full and exclusive right and liberty of making, using, and vending to others to be used, the said im-

provement, a description whereof is given in the annexed schedule and made a part of these presents.

In testimony whereof I have caused these letters to be made patent and the seal of the patent office to be hereunto affixed.

Given under my hand at the city of Washington on this fourth day of April, in the year of our Lord one thousand eight hundred and seventy-one, and of the independence of the United States of America the ninety-fifth.

[L. S] WALTER H. SMITH,
Acting Secretary of the Interior.

Countersigned and sealed with the seal of the patent office.

M. D. LEGGETT,
Commissioner of Patents.

584 United States Patent Office.

Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, Prussia.

Improvement in dyes or coloring matters from anthracine.

Specification forming part of letters patent No. 94,465, dated October 5, 1869; reissue No. 4321, dated April 4, 1871.

Division B.

To all whom it may concern:

Be it known that we, Charles Graebe, of Frankfort-on-the-Main, and Charles Liebermann, of Berlin, in the kingdom of Prussia, have invented a new and useful improvement in the manufacture of alizarine; and we do hereby declare the following to be a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same.

We first change the anthracine into anthrakinon (oxanthracine) a substance known to the chemists by the investigations of Anderson. For this purpose we take one part, by weight, of anthracine, two and a half parts, by weight, of bichromate of potash, and ten or fifteen parts, by weight, of concentrated acetic acid, and we heat these substances together in a vessel, either of glass or clay, to about 100° centigrade to 120° centigrade, till nearly all of the bichromate of the potash is dissolved and the liquid has acquired a deep green color. We then recover the ascetic acid not consumed in the reaction by distillation, and treat the residuum with water to remove the chromic acetate. From the insoluble mass we obtain the anthrakinon in a pure state by distilling the whole from a retort of glass or iron.

In the place of acetic acid, sulphuric acid, diluted with one or two parts of water, may be employed.

Instead of the method just described we also employ the follow-

ing one: We heat anthracine in a vessel of glass or clay, with ten parts of concentrated acetic acid, to about 100° centigrade, or a little higher, and we add nitric acid of about 1.3 specific gravity, in small portions, till the violent reaction ceases. After distillation of the acetic acid we purify the residuum as before. We then convert the anthrakinon, prepared by one of the methods described, into bibromanthrakinon. For this purpose we take three parts of anthrakinon, five parts of bromine, and we heat these substances for ten or twelve hours, or until nearly the whole of the bromine has disappeared, to a temperature, by preference, of about
585 100° centigrade, in a suitable close vessel, either of glass or enameled or glazed iron, which is capable of sustaining the pressure which is generated by the reaction. The apparatus is then allowed to cool. It is opened in order to permit the escape of bromic acid, which can be recovered by absorption either in water or in alkaline solution.

We purify the bibromanthrakinon remaining in the vessel, as a solid substance, by crystallization from benzole.

Instead of the method above described for preparing bibromanthrakinon, we also employ the following: We convert, first, the anthracine into a bromine derivative, into the tetrabromanthracine, known to chemists by the investigations of Anderson. We take one part of this tetrabromanthracine and we heat it in a retort of glass or clay with about five parts of nitric acid, of about 1.3 specific gravity, to 100° centigrade, as long as vapors of bromine are evolved. We distill off the greater portion of the nitric acid, wash the residuum with water, and purify it by crystaallization from benzole. We thus receive the bibromanthrakinon, as before, in a yellow solid mass. We then convert the bibromanthrakinon into alizarine. For this purpose we take one part of bibromanthrakinon, two to three parts of caustic potash or soda, and so much water as is necessary to dissolve the alkali, and we heat the same in an open vessel of glass, glazed or enameled iron or silver, to about 180° to 260° centigrade, for one hour, or till the mass has acquired a deep blue color. We then dissolve it in water, and filter the violet solution, from which we precipitate the alizarine by inorganic acid. We collect the yellow flocks of alizarine thus obtained on a filter and wash them with water.

By these methods we receive the alizarine in a form in which it can be employed in the same manner as the different preparations from madder.

In the place of bromine, chlorine, also, may be employed, but not so conveniently, as the reactions above described are more difficult to accomplish with chlorine than with bromine.

What we claim as new, and desire to secure by letters patent, is—

Artificial alizarine produced from anthracine or its derivatives by either of the methods herein described, or by any other method which will produce a like result.

This specification signed by us this 30th day of November, 1870.

CHARLES GRAEBE.
CHARLES LIEBERMANN.

Witnesses as to the signature of Charles Liebermann:

H. KREISMANN.
G. MAUFE.

Witnesses:

OTTO PETZKE.
ROBT. PRENDS.

586 *Complainants' Exhibit B.*—R. E. S., examiner, &c.

The U. S. Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office.

In testimony whereof, I, Ellis Spear, acting commissioner of patents, have caused the seal of the patent office to be hereunto affixed this fifteenth day of May, in the year of our Lord one thousand eight hundred and seventy-five, and of the independence of the United States the ninety-ninth.

[L. S.]

ELLIS SPEAR,
Acting Commissioner.

Assignment.

Liber I[15], page 260.

Whereas, we, Charles Graebe, of Frankfort-on-the-Main, and Charles Leibermann, of Berlin, Prussia, did obtain letters patent of the United States of America for certain improvements in process of preparing alizarine, which letters patent bear date the fifth day of October, eighteen hundred and sixty-nine, and are numbered 95465, which letters patent were surrendered, and new letters patent were obtained by us for the same invention in two divisions, dated April 4, 1871, and numbered 4302 and 4321 respectively;

And whereas Badische Anilin and Soda Fabrik, in Ludwigshafen, a corporation organized under the laws of the Grand Duchy of Baden, German Empire, is desirous of acquiring an interest therein—

Now, this indenture witnesseth, that for and in consideration of the sum of five dollars to us, the said Charles Graebe and Charles Liebermann, in hand paid, the receipt of which is hereby acknowledged, we have assigned, sold, and set over, and do hereby assign, sell, and set over unto the said Badische Anilin and Soda Fabrik, in Ludwigshafen, its successors and assigns, all the right, title, and interest we have in the said invention as secured to us by said reissued letters patent.

The same to be held and enjoyed by the said Badische Anilin

and Soda Fabrik, in Ludwigshafen, for its own use and behoof, and for the use and behoof of its legal representatives, to the
587 full end of the term for which said letters patent are granted, as fully and entirely as the same would have been held and enjoyed by us, if this assignment and sale had not been made.

In testimony whereof we hereunto set our hands and affix our seals this first day of March, eighteen hundred and seventy-two.

CHARLES GRAEBE. [SEAL.]
CHARLES LIEBERMANN. [SEAL.]

Sealed and delivered in presence of—
Dr. C. A. KNOYE,
MERLIN METTELSTR, 42.

[U. S. rev. stamp, 5 cents, cancelled March 5, 1872.]
Recorded March 28, 1872.
Ex'd, J. A. W.

Complainants' Exhibit Higgin & Co.'s Bill, No. 1.—R. E. S., examiner, July 1, 1875.

PROVIDENCE, *August 6th*, 1874.

Oriental Print Works:

Bought of JAMES HIGGIN & CO.,
(*Late John Lloyd & Co.*)
MANUFACTURING CHEMISTS, &C.

1 cask of artif'l alizarine,
1406–474
67

407 lbs. nett, at $1\frac{00}{100}$, gold.....407.00

588 *Complainants' Exhibit Higgin & Co.'s Bill*, No. 2.—R. E. S., exam'r, July 1, 1875.

PROVIDENCE, *August 28th*, 1874.

Oriental Print Works:

Bought of JAMES HIGGIN & CO.,
(*Lare John Lloyd & Co.*)
MANUFACTURING CHEMISTS, &C.

4 casks of artif'l alizarine,
1403=484.....70
1549=451... ..67
1552=436.....60
1554=464.....61

Overweight 1832	1835	258
	258	

1577 lbs. nett, at 1.00 gold..... ...1577.00

Complainants' Exhibit Higgin & Co.'s Bill, No. 3.—R. E. S., examiner, July 1, 1875.

PROVIDENCE, *Sept. 1st*, 1874.

Oriental Print Works:

Bought of JAMES HIGGIN & CO.,

(*Late John Lloyd & Co.*)

MANUFACTURING CHEMISTS, &c.

3 pieces of 34-inch lapping, 246 yds., at 87c.....214.02
5 casks of No. 2a artif'l alizarine,
5108=220½
5110=220½
5115=220½
5896=220½
5897=220½

1102½ lbs. nett, at $1\frac{25}{100}$.....1378.12

1592.14(gold.)

589 *Complainants' Exhibit Higgin & Co.'s Bill*, No. 4.—R. E. S., exam'r, July 1, 1875.

PROVIDENCE, *Nov'r 5th*, 1874.

Oriental Print Works:

Bought of JAMES HIGGIN & CO.,

(*Late John Lloyd & Co.*)

MANUFACTURING CHEMISTS, &c.,

1 cask of No. 2a artif'l alizarine double,
8479=211 lbs. nett, at $2\frac{50}{100}$, gold.....527.50

Report on strength.

Circuit Court of the United States for the southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
vs.
JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE, and JOHN SIMPSON.

Testimony taken on the part of the complainants, before R. E. Stillwell, examiner, to be used on the final hearing of said cause before the Circuit Court of the United States for the southern district of New York, in equity.

THURSDAY, *July 1st*, 1875.

Present: John Van Santvoord, Esq., and George Gifford, esq., counsel for complainants; William H. Arnoux and Gilbert M. Plympton, esqs., counsel for defendants.

Counsel for complainants offer in evidence certified copy reissued letters patent, granted to Graebe and Liebermann, and dated April 4th, 1871, and numbered 4321, marked "Complainants' Exhibit A," R. E S., examiner, &c.

590 Also, a certified copy of an assignment from the patentees of said patent, the certificate thereof dated the 26th day of August, 1873, and the assignment dated March 1st, 1872, recorded March 28, 1872, in Liber I^{15}, page 260, marked "Complainant's Exhibit B," R. E. S., examiner, &c.

BENJAMIN S. HEDRICK, a witness produced on the part of the complainants, being duly sworn, deposes and says as follows, in answer to interrogatories propounded to him by counsel for complainant:

Q. 1. What is your name, age, residence and occupation?

A. Benjamin S. Hedrick; age 48 years; reside in the district of Columbia; my occupation general chemical examiner in the United States patent office, and professor of chemistry in the Georgetown medical college, Washington, D. C.

Q. 2. How long have you been employed in the patent office in connection with its chemical department?

A. Over fourteen years.

Q. 3. What was your profession before you was connected with the patent office?

A. I was professor of chemistry in the university of North Carolina, and for some time an analytical chemist and a lecturer on chemistry in the city of New York.

Q. 4. Have you read and examined complainants' patent reissue No. 4321, marked Exhibit A, and do you understand the contents thereof?

A. I have and do.

Q. 5. What can you say respecting the novelty of the artificial alizarine which is described in said letters patent, Exhibit A?

A. The material which is named artificial alizarine, and which is the subject matter of this patent, is one entirely new at the date at which the application for the patent was made; it had not been previously known or described.

Q. 6. What, if anything, distinguishes it from all other things before known, so far as you know or believe?

A. In the first place, it is new as to its origin; in the second place, it is new in its chemical properties; also, thirdly, in its physical characters.

Q. 7. And you, previous to your acquaintance with the artificial alizarine made known in said patent, knew of the uses of madder or alizarine obtained from madder, in coloring?

A. I had; the use of madder and various preparations from the madder plant, as coloring materials, have been known from time immemorial.

Q. 8. What is the difference, if any, between the alizarine
591 obtained from madder and the artificial alizarine specified in complainants' patent, Exhibit A?

A. I would say in the beginning, before answering the question, that the name alizarine is used by chemists and by the manufacturers of dyestuffs in quite different senses, and refer to things quite different. The alizarine of the chemists is a rare preparation, not used for any practical purpose. The manufacturers of dyestuffs have also for a long time made and sold materials under the name of alizarine which are derived products from the madder plant. These are mixtures of a great many different chemical products, and are used in connection with mordants in dyeing and printing. This artificial alizarine is produced from an old material known as anthracine. The anthracine itself, as used in all the practical arts, is not a chemically pure substance. The artificial alizarine is produced from the commercial anthracine by the processes set forth in the specification of this patent. This material, when examined both chemically and practically, gives characters which easily distinguish it from any of the dye materials previously known. There is no difficulty whatever in distinguishing it from the madder products, the chief point of resemblance being that this artificial alizarine and the madder preparations are used in dyeing and printing. There are so many points of difference that it would be very difficult to enumerate them all. It is sufficient, however, to say that they are not at all likely to be confounded, the one with the other, by persons using them. They are substantially different from each other; really different things.

Q. 9. Have you examined the material contained in this bottle which I now show you, and if so, state what you find the same to be?

A. I have examined it, and find it to be artificial alizarine, the same material described and claimed in the patent, Exhibit A.

(Counsel for complainants offers the said bottle and contents in evidence, and the same is marked "Complainants' Exhibit C.")

Q. 10. State who gave you the material, Exhibit C, to examine, if any one, and when, about?

A. I received it from the hands of William Hauff on the 6th of April, 1875. The portion now contained in this bottle is a part of a larger bottle of the material, the said larger bottle having upon it, at the time I received it, the label now attached to the bottle Exhibit C, which label is in the following words: "B. S. H., April 6th, 1875. Apr. 5, '75, W. H. 16th, '74, Higgins—Alizarine, from Oriental Pt. Works, K. April 5, '75."

Q. 11. Are any of the letters or figures upon that label in your hand? If so, which?

A. They are as follows: "B. S. H., Apr. 6, '75."

592 Cross-examined:

x-q. 12. When did you first know alizarine, both natural and the so-called artificial?

A. I first knew the artificial alizarine by the specimens which accompanied the application of Graebe and Liebermann for the original patent, of which Exhibit E is a reissue. The madder alizarine I have known for many years—about twenty years.

x-q. 13. When did you first know anthracine, and what is it?

A. I have known of it for a long time, but when I knew it first I could not say. It is one of the hydro-carbons derived from the coal-tar gas-works.

x-q. 14. Did you ever extract alizarine from it?

A. I have not.

x-q. 15. Did you ever see it extracted from it?

A. I have never seen it extracted from it.

x-q. 16. Do you know of your own knowledge, as a fact, that alizarine is extracted from it?

A. I only know, as an admitted fact by all the world, that artificial alizarine is made from it; it is not extracted from it.

x-q. 17. Do you say that alizarine is made from anthracine? If yes, state how it is so made, if you know?

A. It is made by converting the anthracine into anthraquinone, and oxidising the anthraquinone to form artificial alizarine.

x-q. 18. What is the difference between anthraquinone and anthracine?

A. You substitute for part of the hydrogen in the anthracine, oxygen, so that it is sometimes called ox-anthracine.

x-q. 19. Give, if you can, the chemical formula for anthracine, and the chemical formula for anthraquinone?

A. Theoretical chemists have from time to time assigned different theoretical formulas. At the present time, what appears to be the most accepted formula is, for anthracine, C^{14} H^{10}; anthraquinone, C^{14} H^{8} O^{2}; artificial alizarine, C^{14} H^{8} O^{4}. These are, however, abstract matters, theoretical formulas, that do not fully represent the commercial articles, which are the materials known as madder alizarine and artificial alizarine of this patent.

x-q. 20. Then do you mean to be understood by your last answer that there are no fixed and certain formulas recognized by chemists that will designate the elements of anthracine and anthraquinone and alizarine?

A. There is no dispute among chemists as to the elements contained in these materials; the matters in dispute are the theoretical formulas involved.

x-q. 21. Question repeated, with the words "proportions of the" before "elements" added.

593 A. There are not; only such as I have already stated are most generally accepted. It is also well known to chemists that identity of elements and identity of proportion do not always produce identity of product.

x-q. 22. In your answer to the 19th cross-question you say "theoretical chemists have from time to time assigned different theoretical formulas." What formulas have practical chemists assigned to anthracine, anthraquinone and artificial alizarine?

A. They have not assigned any.

x-q. 23. What is natural alizarine made from?

A. I don't believe that any such substance as natural alizarine exists.

x-q. 24. State the grounds of this belief?

A. No one has ever collected any.

x-q. 25. What do you call the alizarine that is made from madder? Do you call that artificial?

A. It is a peculiar preparation from the madder plant; that is, it is the madder plant treated with chemicals, so as to make it suitable for certain useful applications in the dyer's art. The word artificial alizarine has been appropriated to this new and useful article, invented by Graebe and Liebermann, and described in this patent, Exhibit A. The preparations known as alizarine prior to this invention were artificial in the sense of being a product of art; they were not, however, called artificial.

x-q. 26. State, if you please, as a matter of fact, whether alizarine made from madder is a natural or artificial product.

A. It is an artificial product or preparation.

x-q. 27. Is madder alizarine a substance existing in the madder plant, and extracted therefrom by a scientific process, or is it a new article formed from madder during its manipulation with chemicals?

A. Both views have been held at different times by different chemists; that is, theoretical chemists. The practical chemists have not mooted the question, but were satisfied if, by their manipulations, they could obtain products useful in the arts. For myself, I have never examined the question theoretically.

x-q. 28. If you have never examined this matter theoretically, have you done so practically, and with what result?

A. I have; and with the result that the substance now so much in use, and known as artificial alizarine, is not any one of the madder products heretofore known.

x-q. 29. Give the chemical formula of the alizarine made from madder, and of the alizarine made in accordance with the complainants' patent, as deduced from your own practical workings of the same?

A. I have made none, and no formula would represent either the commercial madder preparations or the new artificial alizarine.

594 x-q. 28. Express, then, in some way, other than by formula, the chemical differences between the two kinds of alizarine inquired of, if you can.

A. One way, not a very accurate one, is to examine them under a high magnifying power of the microscope; this I have done.

Another is to obtain an extract by means of bi-sulphide of carbon, and evaporate the extract and obtain the extract in crystalline form. You get no crystals from the madder products, but they are quite abundant from the artificial alizarine. Another test is to sublime the different products in a tube, and examine the crystals formed on the cooled portions. Still other methods, by decomposing the two kinds of dyestuffs. The madder alizarine will give products indicating its vegetable origin. There are still other tests, some of which I have seen, but a practical dyer will explain them much better than I could.

x-q. 29. Have you made all these tests yourself? If not, which of them did you make?

A. I have made them all.

x-q. 30. Are you very certain that alizarine made from madder will not produce crystals from sublimation or chemical test?

A. They will be produced, but they will be different from the other.

x-q. 31. State whether the crystals produced from the madder alizarine are known as acicular crystals.

A. They are.

x-q. 32. State whether the crystals produced from alizarine made under complainants' patent are what are known as acicular crystals.

A. They are.

x-q. 33. What difference does the microscope test reveal when the madder alizarine and the patented alizarine are examined by it?

A. The anthracine alizarine has always some traces of the anthraquinone in it. It has no remains of vegetable cells. The madder alizarine has no anthraquinone. It has remains of vegetable cells, little fibres peculiar to the plant, amorphous, waxy-appearing matter, and less crystalline structure.

x-q. 34. Could not the vegetable cells be removed from the madder alizarine without impairing it as a dyeing principle? In fact, would it not be improved if these cells were removed?

A. I do not know; I have no experience in the matter.

x-q. 35. When you say you don't know, do you mean that you do not know whether the coloring principle is due to the presence of the vegetable cells or not?

A. No; it is possible that any treatment that would remove the vegetable cells would destroy the whole matter. I meant simply to say, I did not know anything about it.

x-q. 36. Could not the amorphous waxy matter be removed
595 from the madder alizarine without destroying, but rather improving its dyeing property?

A. I do not know that it could.

x-q. 37. Do you mean by your last answer that you know nothing about it?

A. I do.

x-q. 38. Is not it your opinion that if the cellular tissues and the amorphous waxy matter were removed from the madder alizarine, that it would be improved as a dyeing principle, and that to the presence of these substances is due, in a great measure, the fact that the microscope does not reveal crystalline structure?

A. Inasmuch as I know of no means by which these things could be removed, I am unwilling to hazard an opinion as to what the effect would be.

x-q. 39. Is it not true that madder alizarine does not contain all the cellular tissue, woody fibre, and amorphous waxy substance found in the madder plant, from which it is extracted, but, on the contrary, only a very small portion of that?

A. I answer yes, if the word prepared is substituted for the word "extracted," for it is not an extract at all, but a preparation.

x-q. 40. Will you say, as an expert, that if the amorphous waxy substances—the fibre and the cellular tissue—were removed from the madder alizarine, that it would not then reveal, under the several tests you have named, identically the same characteristics as does the patented alizarine under such tests?

A. I have no knowledge of the subject.

x-q. 41. Please state what you understand a hydro-carbon to be, chemically and commercially.

A. Chemically, a hydro-carbon means a substance containing only carbon and hydrogen. Commercially, the most important classes of these compounds are those corresponding to the coal-tar or gas-tar products and the petroleums or bitumens. There are also several of the essential oils that are hydro-carbons, such as spirits of turpentine; attar of roses, I believe, is another. There are others.

x-q. 42. How do you class anthracine?

A. It belongs to the coal-tar series, and is a hydro-carbon.

x-q. 43. Were you the examiner in the United States Patent Office who passed upon Graebe and Liebermann's original application for the patent, and also upon the reissue of that patent now in suit?

A. I did examine and pass upon both those applications.

x-q. 44. Did you suggest any amendments to either of the applications?

A. I did, I believe.

x q. 45. To which of them?

596 A. Certainly in the reissue, and I am inclined to think in both.

x-q. 46. Why did you suggest the amendments, and what was the nature of them? State fully and particularly.

A. The object of the amendments was to more clearly define and fully set forth the invention; just what the particulars were, I could not now state. I think that some of the amendments were merely formal, to correct some inaccuracies of language, and

Another is to obtain an extract by means of bi-sulphide of carbon, and evaporate the extract and obtain the extract in crystalline form. You get no crystals from the madder products, but they are quite abundant from the artificial alizarine. Another test is to sublime the different products in a tube, and examine the crystals formed on the cooled portions. Still other methods, by decomposing the two kinds of dyestuffs. The madder alizarine will give products indicating its vegetable origin. There are still other tests, some of which I have seen, but a practical dyer will explain them much better than I could.

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A. I answer yes, if the word prepared is substituted for the word "extracted," for it is not an extract at all, but a preparation.

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A. Chemically, a hydro-carbon means a substance containing only carbon and hydrogen. Commercially, the most important classes of these compounds are those corresponding to the coal-tar or gas-tar products and the petroleums or bitumens. There are also several of the essential oils that are hydro-carbons, such as spirits of turpentine; attar of roses, I believe, is another. There are others.

x-q. 42. How do you class anthracine?

A. It belongs to the coal-tar series, and is a hydro-carbon.

x-q. 43. Were you the examiner in the United States Patent Office who passed upon Graebe and Liebermann's original application for the patent, and also upon the reissue of that patent now in suit?

A. I did examine and pass upon both those applications.

x-q. 44. Did you suggest any amendments to either of the applications?

A. I did, I believe.

x q. 45. To which of them?

596 A. Certainly in the reissue, and I am inclined to think in both.

x-q. 46. Why did you suggest the amendments, and what was the nature of them? State fully and particularly.

A. The object of the amendments was to more clearly define and fully set forth the invention; just what the particulars were, I could not now state. I think that some of the amendments were merely formal, to correct some inaccuracies of language, and

to make the specifications conform to the requirements of the law and the rules of the office.

x-q. 47. Please to state whether or not this is not a fact, that the original patent to Graebe and Liebermann was not issued upon the original application filed by them, but that the entire specifications and claims were rewritten and changed materially, new facts inserted, so that nothing remained of the original application, save the oath and signatures, and that upon this rewritten specification the original patent issued?

A. The specification was entirely rewritten, I believe, and a great many slight amendments made in the verbiage of the specification; idioms of language were corrected, but no new matter was introduced, no description of anything not set forth in the original papers. It is very common, when a large number of amendments are made, to rewrite the entire specification; the office generally required this, especially in the case of inventors not fully familiar with the English language.

x-q. 48. Will you state positively that no new matter was incorporated in the rewritten specification of the original application?

A. I answer positively that no new invention or any part of an invention was inserted into the rewritten specification of the original application by the attorneys or anybody else.

x-q. 49. You have heard read to you all the foregoing questions and answers. Is there anything in your answers you would like to strike out or amend before adjournment?

A. There is nothing.

B. S. HEDRICK.

Adjourned to Friday, July 2d, at 11 a. m.

597 NEW YORK, *July* 2, 1875, 11 a. m.

Present: As before, and the witness, B. S. HEDRICK, who, being further cross-examined by Mr. Plympton, says:

x q. 50. How long had anthracine been known in the arts, and for what purpose had it been used?

A. I think it had been known since 1832—I am not positive as to the date; it has been used in itself only in a crude condition, with other less volatile parts of coal-tar; and for the same purpose that the coal-tar has been used for, its great importance in the arts has risen in the manufacture of this product—artificial alizarine—which is a dye stuff.

x-q. 52. Has anthracine been used for any other purpose in the arts than as a base for alizarine?

A. No other important use that I can recall.

x-q. 52. From what substances is anthracine obtained; name them in detail, if you please?

A. Most abundantly from the distillation of bituminous coals, as in the usual manner of making common illuminating gas; but it

can be obtained by the destructive distillation of vegetable matters, which will produce coal-tar products.

x-q. 53. Did you ever know anthracine to be produced from substances other than of vegetable origin?

A. I do not know it to be so produced, but think it highly probable that it could be made from matters of animal origin; it is usually associated with napthaline and other products belonging to what is called the napthaline series of hydro-carbon.

x-q. 54. How long have you known dyeing substances to be derived from anthracine?

A. Only since the invention of Graebe and Liebermann.

x-q. 55. You state in your answer to the 8th direct q. "that the name alizarine is used by chemists and by the manufacturers of dye stuff in quite different senses," and refer to things quite different. Now, state in what sense the name alizarine is used by chemists, and what chemical alizarine is, and in what sense the name alizarine is used by manufacturers, and what the manufacturers' alizarine is, giving in detail the difference which exists between the two?

A. The name alizarine as a chemical term, I believe, was first used by Schunk to designate a well-defined crystalline compound obtained by the chemical treatment of the madder plant. This compound is not a material that can be used for dyeing. Some French manufacturers of madder preparations for dyeing have made a compound or preparation—not a definite chemical compound, however, but a mixture of many things—which they name
598 alizarine; I think, however, it is not much used by dyers.

The other alizarine is the product obtained by Graebe and Liebermann by the treatment of anthracine; it is a very valuable dye-stuff, having distinct characteristics, and is not a single definite compound as was Schunk's alizarine, nor is it the madder preparation known to the dyers before the date of Graebe & Liebermann's invention.

x-q. 56. Do you mean to say in your last answer, or do you wish to be understood, that alizarine derived from madder is not suitable for dyeing purposes?

A. I have stated that a preparation called alizarine had been made from madder, which was used for dyeing; I also said that was not the invention of Graebe and Liebermann. I said, also, that Schunk had prepared a definite chemical compound, which he called alizarine, which was not a dyeing material—not suitable for dyeing; it has not even the useful properties of the madder plant.

x-q. 57. Then you wish to be understood as saying that alizarine produced from madder is useful for dyeing purposes, but that Schunk's madder alizarine was not useful therefor, do you?

A. I do. The preparation called alizarine by the manufacturers of dye-stuffs was quite similar to madder extract Garancine, and other commercial names that have been given to the various madder preparations.

x-q. 58. Please answer that part of the previous question which asks you to give in detail the difference between chemical alizarine and manufacturers' alizarine?

A. I do not believe that I could give it more definitely than I did in my examination yesterday, where I indicated how you might easily distinguish Graebe and Liebermann's artificial alizarine from the madder alizarine. I stated then, however, that there were differences that could be better explained by practical dyers than myself.

x-q. 59. Are the differences referred to by you in your last answer the only differences that exist between alizarine made from madder and alizarine made under the plaintiff's patent?

A. I have every reason to believe they are not; for at every examination of the several dye materials, the fact becomes more and more apparent that they are altogether different things.

x-q. 60. Name other differences which exist between the two substances than those already given by you.

A. I did not say that I had them now. I think the difference is already sufficiently defined; but if any competent man will say that he is unable to distinguish the artificial alizarine of Graebe and Liebermann from the previously known dye-stuffs from madder, I will endeavor to point out more differences than I have already given.

(The whole of the last answer objected to as irresponsive,
599 and)—

x-q. 61. Question repeated.

A. I meant to say that any competent chemist or dyer could easily distinguish Graebe and Liebermann's dye-stuff from any other dye-stuffs made from madder prior to Graebe and Liebermann's invention. I meant also to say that I had not now in my memory other differences in such form that I could give them as testimony.

x-q. 62. Do you, or not, know of any other differences than those you have enumerated to exist between plaintiffs' alizarine and madder alizarine—a direct answer is requested?

(Objected to, because it has been already answered.)

A. I have none in my recollection.

x-q. 63. Is the alizarine of the plaintiffs purer than madder alizarine?

A. I do not know what the word "purer" means in that connection.

x-q. 64. Is the plaintiffs' alizarine freer from foreign substances than madder alizarine?

A. I do not know what "foreign substances" mean in that connection.

x-q. 65. Is the plaintiff's alizarine purer — using the word "purer" in its general acceptation—than is madder alizarine?

A. As the two substances are different things entirely, it is impossible for me to answer that question—yes, or no. As met with in commerce, both are sometimes adulterated, and some things are

added to make them in proper form for use, according to the application to be made of them.

x-q. 66. You tested, did you not, as a chemist, the plaintiff's alizarine; did you find that adulterated?

A. It had a good deal of water in it; nothing that I think injurious.

x-q. 67. Have you ever tested, chemically or otherwise, alizarine made from madder that was not adulterated?

A. I have; I have taken the pure madder root itself.

x-q. 68. Now, which of the two—that is, the plaintiffs' alizarine and the madder alizarine—contains the greatest percentage of chemically pure alizarine?

A. I do not know.

x-q. 69. Did you ever test the two kinds to arrive at such a result?

A. I did not; nobody wants chemically pure alizarine in the arts, especially in the art of dyeing.

x-q. 70. Will you say that madder alizarine does not contain a certain proportion of alizarine, which would be chemically pure as such if all the other substances found in connection with it were removed?

A. I have no knowledge on that subject of my own, but writers on the practical art of dyeing assert the contrary.

x-q. 71. Please give the names of such writers, and titles of the books they have written, containing such statements.

A. Without reference to notes and memoranda I could not
600 give an exact statement of this matter, but from memory I refer to *Napier's Chemistry applied to Dyeing*, published by Henry Carey Baird, at Philadelphia, in 1853, pages 351, 352, 353, 354. I cannot name from memory any others with certainty.

x-q. 72. State in substance what Napier says on the subject?

A. He states that the madder plant had been very carefully examined by chemists; they found, during their researches, that they could obtain two well-defined chemical compounds, but that these were not all that it contained; that these were zanthine and alizarine (using Schunk's nomenclature.) It was hoped that these would be the valuable parts of the plant, or the valuable products derived from it; for it has always been a disputed point whether even these existed naturally in the plant, but when tested by practical application they were found to be of no value as dye stuffs.

x-q. 73. Will you say that plaintiffs' alizarine does not contain a certain proportion of alizarine, which would be chemically pure as such if all the other substances found in connection with it were removed?

A. I have no knowledge on the subject. I have already stated, however, that chemical compounds may have the identical chemical composition and not be the same things.

x-q. 74. Do you mean to say that you never tried the experiment for the purpose of ascertaining the parts inquired of in the last question?

A. I never did.

x-q. 75. In your answer to the 6th direct q., you state that the plaintiffs' alizarine is new in its chemical properties. What are those "new" chemical properties?

A. I cannot answer further than I did in my cross-examination yesterday.

x-q. 76. What are its new physical characteristics, mentioned by you in your 26th answer?

A. I can recollect those I mentioned yesterday in reference to their appearance when examined by a microscope.

x-q. 77. Were those that you mentioned yesterday all that you can recall?

A. All that I can recall as coming under my own observation, but writers on the matter mention others.

x-q. 78. Name the writers that mention other physical differences, and the substance of what they state?

A. This I could not give without reference to notes and memoranda.

x-q. 79. You may refer to that memoranda that you have with you in this instance, and give the desired information therefrom?

A. I would refer to *The London Journal of Arts* for the last five years; *The London Chemical News* and *The Journal of the London Chemical Society*, for the same periods.

Examination of this witness adjourned to July 3d, 1875, at 11 a. m.

601 NEW YORK, *July 3d*, 1875, 11 a. m.

Present: Counsel as before.

Continuation of cross-examination of B. S. HEDRICK:

x-q. 80. Give the years of publication of the numbers of the several books you have named, in which this statement occurs?

A. Since 1870, inclusive.

x-q. 81. You have stated in your testimony, given in an another suit under this patent, as follows: "What is known by dyers as alizarine madder is not the alizarine of Graebe and Liebermann; there is the same sort of difference as there is in iron as known to theoretical chemists, and iron known to the arts." Can you explain more fully what the difference is between the two kinds of iron referred to?

A. The iron as known to chemists is only a hypothetical thing, a matter that is reasoned out by analogies and inferences. The chemists have not for twenty years at a time assigned the same atomic light or combining number to what they designate as the element iron. But iron is known to the arts as a great many varieties and species. These kinds of iron, such as steel of different kinds, Bessemer metal, bar-iron, cast-iron, malleableized-iron, and many others—these are well known and well-defined things. So chem-

ists have supposed that there was a material called alizarine, either naturally in the plant of the madder, or produced by the treatment of the plant. Of course, the same elements were found in all dye stuffs. Some of the elements would be common to the madder plant, and to Graebe and Leibermann's product; but chemists cannot at will take these elements and put them together so as to form whatever compound they desire to produce. Theoretical chemists have long been in the habit of using, in their explanation of facts, what they call hypothetical compounds. Sometimes these hypothetical compounds have served a useful purpose in the advancement of both theoretical and practical knowledge. So far as relates to practical knowledge, that will remain the same, no matter how much the theoretical ideas are changed. In the matter of iron, the practical men will easily distinguish one kind from another; but the theoretical men are constantly changing their opinions as new facts are brought to their notice.

x-q. 82. What elements are found in common in the patented alizarine and the madder alizarine?

A. Carbon, hydrogen, and oxygen.

x-q. 83. Did you ever compare miscropically, chemically, or in any way, madder alizarine, from which has been eliminated woody fibre, and the amorphous and waxy material with the patented alizarine?

602 I have not, for the reason that no such dye stuff from madder is to be found in commerce or been described in any work; and, as I stated yesterday, the very existence of such a material which would serve any purpose in the art of dyeing, is denied.

x-q. 84. Did you ever make a spectroscopic analysis of the two kinds of alizarine we have been talking of?

A. I have not.

x-q. 85. Did you resolve into their elements the two kinds of alizarine we have been talking of?

A. Not into their elementary principles.

x-q. 86. Be kind enough to state, explicitly, the exact nature of the analysis you subjected the two kinds of alizarine to, by which you determined these supposed existing differences between them?

A. I have not mentioned two kinds of alizarine. I have mentioned that there were various madder preparations used in dyeing, some of which have been sold under the name of alizarine, and I have mentioned this new dye stuff invented and patented by Graebe and Liebermann. I have already indicated how these are clearly distinguished the one from the other.

x-q. 87. Then is it a fact, that you have never made a careful analysis of the patented alizarine nor of the madder alizarine, to determine, if possible, wherein they differ one from the other?

A. I have frequently done this, and have so stated in this examination. I have also stated that I had probably not given all the differences. I do not think that resolving compounds into their original elements is the proper method of determining what they

are. You might as well burn up a man's brain to ascertain its quality.

x-q. 88. Was the sulphide of carbon process, the analysis you refer to, when you you say, "I have frequently done this." meaning, made a careful analysis of the patented and madder alizarine; if not, please to state again what that analysis was?

A. I called it a bi-sulphide of carbon test, and not process. We decide that idenity or want of idenity by the characters which we find the substance to possess. These are sometimes physical characters, sometimes chemical reactions, sometimes the relation of the material to solvents, and sometimes by the results brought out in the practical use of the material.

B. S. HEDRICK.

Sworn to before me, this 3d day of July, 1875.

R. E. STILWELL, *Examiner, &c.*

603 United States Circuit Court, southern district of New York.

BADISCHE ANILINE AND SODA FABRIK
vs.
JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE and JOHN SIMPSON. } In Equity.

NEW YORK, *Dec.* 6th, 1876.

Present—J. Van Santvoord, esq., for complainants; G. M. Plympton, esq., for defendants.

BENJAMIN S. HEDRICK, being recalled by complainants, in answer to questions asked by counsel for complainants, says:

Re-q. 1. In your previous testimony taken in this case, in answer to cross-question 19, you speak of a formula which you say was most accepted for artificial alizarine, please hear read that question and answer and state more fully what you mean by that statement?

(Objected to by defendant's counsel as fully explained in the answer of the witness.)

A. I find by the printed testimony in that case that I am made to say that the formula for artificial alizarine is $C_{14} H_8 O_4$. The word "artificial" is certainly an error. If I used any qualifying adjective it must have been "chemical," and this distinction will be clearly understood by comparing this answer with the answer in the same examination, and therefore I desire that the word "artificial" be erased and the word "chemical" substituted.

Re-q. 2. What do you mean by the term "chemical alizarine?"

A. The same as given by me in answer to question 8, as "the alizarine of the chemists," which is a rare preparation not used for any practical purposes.

604 Re-cross:

Re-x-q. 3. Have you compared the original record of your testi-

mony with the printed copy to which you refer in your answer to the first redirect question, and do find in that original record the word "artificial," as referred to in the first redirect question?

A. I have just now done so, and I find that the word "artificial" is in the manuscript.

B. S. HEDRICK.

Subscribed and sworn to before me, this 6th day of December, 1876.

R. E. STILWELL, *Examiner, &c.*

605 JOHN D'ARCY, a witness produced and sworn on the part of the complainant, testifies as follows:

Q. 1. What is your name, age, residence, and occupation?

A. My name is John D'Arcy; I am 36 years of age; I reside at Apponaug, Rhode Island; I am superintendent of the Oriental Print Works.

Q. 2. How long have you been superintendent?

A. Sixteen months.

Q. 3. Is it part of your business as superintendent to order supplies for the works?

(Objected to as immaterial.)

A. In the absence of the treasurer? Yes.

Q. 4. Has the Oriental Print Works ever bought from James Higgin & Co., of Providence, Rhode Island, any artificial alizarine, and if so, when?

(Objected to as incompetent.)

A. Yes; the date of which purchases are Aug. 6, 1874; Aug. 28, 1874; Sept. 1, 1874, and at a later date.

Q. 5. Have you with you the bills of any of those purchases?

A. I have bills corresponding to the dates named; also one dated Nov. 5, 1874.

Q. 6. Will you produce those bills to be put in evidence?

A. Yes.

Counsel for complainants offer in evidence four bills produced by the witness, and they are marked "Complainants' Exhibits, Higgin & Co. bills, 1, 2, 3, 4, R. E. S., Examiner."

Q. 7. Do you know William K. Browne, here present?

A. I do.

Q. 8. State whether or not you know that Mr. Browne ever received from the Oriental Print Works any of the artificial alizarine which the Oriental Print Works purchased from Higgin & Co., as you have stated; and if yea, when did he receive the same, and in what packages, or how put up?

(Objected to as immaterial.)

A. In obedience to the treasurer's orders, I caused samples of the artificial alarazine received from James Higgin & Co. on or about November 5, 1874, to be placed in two small bottles, and given to Mr. William K. Browne on or about November 16, 1874.

606 Q. 9. Will you state whether or not you recognize these bottles here present, one of which is broken, as the bottles which you caused to be delivered with artificial alizarine contained therein, to said Browne?

A. I will not swear to the identity of these bottles, but have no doubt whatever that the bottles and the contents are in fact the bottles and substance that I caused to be given to Mr. Browne.

Q. 10. Were the different purchases of artificial alizarine which are mentioned in these bills you have produced, all of the same kind—I mean the same material?

(Objected to as immaterial.)

A. They are all artificial alizarine, differing in this: The three bills of the earlier dates were single strength, understood by the trade as containing 10 per cent. coloring matter. The last bill named was double strength, supposed to be 20 per cent. coloring matter.

Complainant's counsel offers in evidence one of the bottles and its contents referred to by the witness, which is marked "Complainant's Exhibit D, R. E. S., examiner."

Cross-examined by Mr. PYLMPTON:

x-q. 11. Did you purchase from Higgin & Co. the alizarine named in the bills, complainant's Exhibit "Higgin & Co. bills," 1, 2, 3, 4?

A. I can't say that I did, because my order books are not here.

x-q. 12. Did you transfer from the broken bottle into the bottle marked Exhibit D, the alizarine contained therein?

A. Both bottles were in good order when they left my possession. I have no knowledge what became of them afterwards.

x-q. 13. How long since is it that bottle Exhibit D left your possession?

A. On or about November 16, 1874, and since that time I do not know what has become of it.

x-q. 14. Then you cannot swear positively, can you, that the alizarine contained in the bottle marked Exhibit D, is alizarine from Higgin & Co.?

A. I will not swear positively; but I conscientiously believe that bottle marked Exhibit D contains the sample of James Higgin & Co.'s artificial alizarine, given to Mr. Browne.

x-q. 15. How many times have you seen the alizarine in bottle Exhibit D since you gave it to Mr. Browne, November 16th, 1874?

A. I saw it but once since, and that was in this office yesterday.

607 x-q. 16. Do you know of your own knowledge in whose hands the bottles of alizarine you gave Mr. Browne in 1874 has been since you gave them to him?

A. I do not.

x-q. 17. Can you state, of your own knowledge, whether the ali-

zarine contained in the bottle marked Exhibit C is some of the Higgin & Co.'s alizarine which you gave Mr. Browne in 1874?

A. No.

JOHN D'ARCY.

Sworn to before me, this 2d day of July, 1875.

R. E. STILWELL,
An Examiner for Southern District of New York.

WILLIAM K. BROWNE, a witness produced on the part of the complainants, having been duly sworn, says:

Q. 1. What is your name, age, residence, and occupation?

A. My name is William K. Browne; I am 34 years of age; I reside at Boston; I am agent for William Pickhardt and Kuttroff.

Q. 2. Have you been present at and have you heard the examinatian of John D'Arcy this day, a witness of the complainants?

A. I have been, and heard him testify.

Q. 3. State whether or not you received from Mr. D'Arcy the two bottles of samples of artificial alizarine, as stated by him; and if so, state where you received them, and what you did with them?

A. I did receive them from him at the Oriental Print Works, at Apponaug, R. I. I carried them with me to Boston, Nov. 16th, 1874, and held the samples in my possession until the 17th Nov., 1874, when I sent those samples of artificial alizarine by Adams' Express to Messrs. William Pickhardt and Kuttroff, 23 Cedar street, N. Y. I have the Adams' Express receipt in my possession now.

Q. 4. State whether or not you identify the bottles, or either of them here present, which you received, as you have stated, from the Oriental Print Works?

A. Yes; I identify them, one of them, ("Exhibit D,") by the label written on by myself, "Nov. 16th, '74, Higgin's alizarine from Oriental Pt. Works;" also by the piece of oilcloth tied over the neck of the bottle.

Q. 5. Look at the label on the small bottle, "Exhibit C," and state if you recognize that as being on the other bottle?

A. I do recognize it as being written by me, and placed on the other bottle.

608 Cross-examined by Mr. PLYMPTON:

x-q. 7. Can you state that the alizarine in bottle marked Exhibit C, is some of the Higgins & Co.'s alizarine that was given to you by Mr. D'Arcy?

A. I cannot.

x-q. 8. Can you state that the alizarine in bottle marked Exhibit D, is the alizarine of Higgins & Co., given to you by Mr. D'Arcy?

A. I cannot.

x-q. 9. To whom did you send the alizarine in the bottle Exhibit D to in Boston?

A. I sent it to Mr. William Pickhardt and Kuttroff, 23 Cedar Street, New York.

x-q. 10. How long was it in their possession?

A. I sent it to them on the 17th November, 1874; I never saw either of the bottles again until I saw them yesterday; one of them here being broken.

WM. K. BROWNE.

Sworn to before me this 1st day of July, 1875.

R. E. STILWELL,
Examiner, &c.

ADOLPH KUTTROFF, a witness produced and sworn on the part of the complainant, says:

Q. 1. What is your name, age, residence, and occupation?

A. My name is Adolph Kuttroff; I am 30 years of age; I reside at the city of New York; I am an importer of colors and dye-stuffs; I am one of the firm of Pickhardt & Kuttroff.

Q. 2. Were you present this afternoon at the examination of William K. Browne, and did you hear him testify?

A. Yes, sir.

Q. 3. State whether or not your firm received bottles containing samples of artificial alizarine from said Browne, and if so, state when and what you know about the same?

A. On November 18, 1874, our firm received a letter from William K. Browne, at Boston, advising that he had expressed to us a package containing 2 bottles containing artificial alizarine, which he had obtained from the Oriental Print Works. On the same day the messenger of the Adams Express Co. handed to me personally, in our office, the said package. I opened the same, and found it contained the two bottles referred to.

609 Q. 4. Is this bottle, "Exhibit D," one of them?

A. Yes, sir.

Q. 5. What became of the other bottle and its contents?

A. I handed it to Mr. William Hauff, April 5th, 1875, with a request to deliver it to Professor B. S. Hedrick at Washington, and I marked on the label, most of which I find now pasted on the small bottle Exhibit C. I marked on it "to W. H., April 5, '75."

Cross-examined:

x-q. 6. Can you state that the alizarine in that bottle marked "Exhibit D" is a sample of the alizarine purchased of Higgin & Co.?

A. Only on information and belief.

x-q. 7. What did you do with the bottle of alizarine which you received from Mr. Browne?

A. One of them I handed to Mr. William Hauff, April 5th, 1875, with a request to carry it to Prof. Hedrick; the other I handed to Prof. Geyer, April 14, 1875, which is the bottle "Exhibit D."

ADOLPH KUTTROFF.

Sworn to before me, this 1st day of July, 1875.

R. E. STILWELL,
Examiner, &c.

WILLIAM HAUFF, a witness produced on the part of the complainant, having been duly sworn, says:

Q. What is your name, age, residence, and occupation?

A. My name is William Hauff; I am 51 years of age; I reside in New York City; I am solicitor of patents.

Q. 2. Do you know Adolph Kuttroff here present?

A. I do.

Q. 3. Did Mr. Kuttroff give to you a bottle to be delivered by you to Prof. Hedrick at Washington; if so, describe the bottle, and state what it contained, so far as you know, and when it was delivered to you, and what you did with it?

A. He delivered to me a bottle about the size and appearance of Exhibit D, containing a label which is now pasted on Exhibit C. The bottle I was told contained Higgin & Co.'s artificial alizarine. I received it on the 5th of April, 1875, and delivered it to Prof. Hedrick in Washington on the succeeding day. I marked the label as follows: "Ap'l 5, '75, W. H."

610 Cross-examined:

x-q. 4. Do you know whether the contents of the bottle Exhibit C is the same material that you delivered to Prof. Hedrick?

A. On a subsequent visit to Washington Prof. Hedrick told me that he had broken the bottle which I had delivered to him; that he had filled some of the contents of said bottle into the bottle "Exhibit C," which he then showed me.

W. HAUFF.

Sworn to before me this 1st day of July, 1875.

R. E. STILWELL,
Examiner, &c.

NEW YORK, *July* 10, 1875, 11 A. M.

Present—Counsel as before.

WILLIAM E. GEYER, a witness produced and sworn on behalf of the complainants, testifies as follows:

Q. 1. What is your name, age, residence, and occupation?

A. My name is William E. Geyer; my age is 26 years; I reside at Hoboken, New Jersey, in Stevens Institute of Technology; I am a chemist, and am a teacher in the high school connected with that institute.

Q. 2. Do you know Adolf Kuttroff?

A. I do.

Q. 3. Look at the bottle and contents marked "Complainants' Exhibit D," and state if you ever had the same in your possession, and if so, how it came into your possession?

A. I had it in my possession; it was given to me by Mr. Adolf Kuttroff on the 14th April, 1875; I marked the label on the bottle for identification as follows: "Apr. 14, W. E. G."

Q. 4. Are the bottle and its contents, Exhibit D, the same bottle and contents which Mr. Kuttroff gave you on the 14th of April, 1875?

A. They are; I took a little of the contents out of the bottle.

Being cross-examined by Mr. Plympton, the witness testifies as follows:

x-q. 5. Can you state of your own knowledge that the contents of the bottle marked Exhibit D are the same in every particular as they were when that exhibit left your possession last?

611 A. When not used by myself, the bottle and contents were kept up under lock and key.

x-q. 6. Question 5 repeated.

A. I do not know what was done with the bottle and contents after they left my possession, which was about ten days ago.

x-q. 7. Now, Mr. Geyer, can you state that you know that the contents of this bottle marked Exhibit D, when the same was in your possession, contained alizarine made by the defendants?

A. I cannot.

Re-direct:

Re-d. q. 8. State whether or not, to the best of your knowledge and belief, the bottle, Exhibit D, and its contents are the same bottle and contents which Mr. Kuttroff gave to you, as you have said, excepting that you took out a little of said contents?

A. I believe they are the same.

WILLIAM E. GEYER.

Subscribed and sworn to before me this 10th July, 1875.

R. E. STILWELL,
Examiner, &c.

612 U. S. Circuit Court, southern district of New York.

BADISHE ANILIN AND SODA FABRIK
vs.
JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE and JOHN SIMPSON. } In Equity.

Testimony in Rebuttal taken on the part of Complainants.

NEW YORK, *August 12th*, 1876.

Present—Mr. J. Van Santvoord, for complainants, and Mr. G.

M. Plympton and Mr. S. Tennie, (of Arnoux, Ritch & Woodford,) for defendants.

Prof. HENRY MORTON, being duly sworn, in answer to interrogatories proposed to him by complainant's counsel, deposes and says:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Henry Morton; age, 39; residence, Hoboken, New Jersey; I am president of the Stevens Institute of Technology of that place.

Q. 2. Have you given any special attention and study to the subject of chemistry?

A. From my boyhood I have occupied myself chiefly with the study and investigation in the subject of chemistry and physics. I have occupied the chair of chemistry in the University of Pennsylvania and in the Philadelphia Dental College. I have made and published in the scientific journals of this country and Europe several investigations in these subjects.

Q. 3. Have you read and do you understand complainants' patent re-issue No. 4321?

A. I have, and I believe that I do.

Q. 4. What special opportunities have you had of acquiring knowledge in reference to the production of artificial alizarine, its composition, and the composition of commercial alizarine derived from madder?

613 A. In the early part of 1873 I had the good fortune to discover in the last products of the distillation of petroleum a new solid hydro-carbon, which has received the name thallene, and which resembles in many respects anthracene, and in fact is probably isomeric with that body. In the course of my study of this substance, I was led to hope that it might prove convertible into artificial alizarine, like anthracene, and to place myself in a position to determine this, I found it desirable to make in my laboratory the various derivatives of anthracene, including artificial alizarine, so that I might be familiar with the reactions of this process, and be enabled to compare them with those I might obtain with my new body. This work has been carried on pretty continuously from that time until the present, and has also been supplemented by numerous experiments in the separation and purification of various bodies constituting the commercial preparations of madder and the dyestuff known as artificial alizarine, and constituting, as I understand, the subject matter of the patent above referred to.

Q. 5. Were your experiments and researches which you have alluded to in your last answer, commenced before you became an expert in this cause, and were they independent of this case?

A. They were commenced long before, as I was not retained in this case until the latter part of 1875, and only a portion of those made since that time have reference to this case.

Q. 6. What is alizarine?

A. The word alizarine, like many other similar names, is used in a strict and in a general sense. In its strict or scientific sense it is used to indicate a definite chemical compound which may or may not have been obtained in a perfectly pure state, but whose composition, if perfectly pure, is assumed to be carbon 14, hydrogen 8, oxygen 4. Moreover the name, as so used, is understood to imply not only that these elements are present in the above relative proportions, but that they are grouped in a certain definite way as regards their relative positions. In the second place, the term alizarine is used by writers generally to describe any mixed substance which is believed to contain, as one of its constituents, in effective proportion, this perfectly definite, though in a certain sense ideal, body above described. In illustration of the use of this term in its most general way, I would refer to Auerbach, "Das Anthracen und seine derivate," page 98, wherein, speaking of a very impure mixture containing many things besides alizarine in the strict sense, he says (which I translate as follows): "The alizarine which separates is colored a dark orange brown." Again, Perkin, in the Journal of the Chemical Society, vol. 23, page 140, uses the following expression: "The coloring matter obtained either by Graebe and Liebermann's original process or from the sulpho-acid of anthraquinone, I have invariably called alizarine."

614 And similar quotations could be multiplied indefinitely. Again, the term alizarine, with a prefix, as for example, green alizarine or yellow alizarine, is used to indicate a substance not regarded by any means as pure by the author using the term, as for instance, in Crook's Handbook of Dying and Calico Printing, London, 1874, page 246, I find as follows: "If the mother liquor "is now allowed to boil for two hours, the so-called green or crude "alizarine separates out and is deposited in twenty-four to thirty "hours as a greenish black mass." Also, on page 266, the word alizarine is used in the same general sense about ten times.

Again, in reference to yellow alizarine, we find that Schützenberger, "Traité des matières colorantes," French edition, vol. 2, pp. 164 and 165, 1867, says as follows: "The green alizarine "treated with alcohol or wood spirit dissolves partially, and gives "solutions of very strong brownish yellow color. By decanting "the clean liquid and evaporating, or better, by distilling it, we "obtain as a residue a brownish yellow alizarine tolerably pure;" and on page 165, in speaking of the extract of green alizarine in coal oil, he calls it "coal oil charged with alizarine." Again, the term alizarine, in the same general and, we may say, loose sense, is used to indicate still cruder preparations, as for example, in Dingler's Polytechnisches Journal, vol. 216, page 451, we have as follows, in a foot note: "It is to be noticed that this Pinkoffin is "more frequently in England as well as in France brought into "commerce under the name of purpurine. This name designates "just the opposite of what the article really represents; it should "rather be called alizarine." And again in Schützenberger, vol.

2, pages 151 and 152, we have as follows: "*Alizarine* (G. Schaeffer) commercial or Pinkoffin—Messrs. Pinkoff, Schunck & Co., of Manchester, introduced into the market during 1854 a variety of garacine known by the name of alizarine. This product presents itself in the shape of a fine powder, of a chocolate color." In fact, I think it is entirely beyond question that the word is used throughout the literature of this subject in the same general way that the term iron is used when we say an iron bridge, an iron building, iron ore, iron salts, or speak of administering iron in medicine, namely, where the idea conveyed is that iron in some condition is present as an available constituent, but by no means implying that even in the opinion of the writer, still less as a matter of fact, it is in a pure condition or the only efficient element present for the purpose or use involved.

Q. 7. In the foregoing answer you have described certain meanings which have been attached by standard authors to the word alizarine. Please explain what is the origin or history of that word, and of its various significations?

A. The word alizarine was first introduced into the literature of chemistry in 1827, when in an article entitled "New Researches on the Coloring Matter of Madder," by Messrs. Colin and
615 Robiquet, read before the French Academy of Sciences on the 6th of November, 1826, and published in the "Annales de Chimie et de Physique," vol. 34, we find on page 240, in reference to crystals of what we may call pure alizarine, obtained from madder by a simple process of washing out and sublimation or of solution with either, the following remark:

"We propose to name them (*i. e.* the crystals) alizarine, which "we take from the word ali-zari, used generally on the Levant, and "which is now established in commerce to designate the entire "madder root."

This material was, however, never applied successfully as a dyestuff, on account, as we now have every reason to believe, of the absence of purpurine as well as of other matters which probably exercise a beneficial influence in the dye-bath.

It was, nevertheless, supposed not only by Colin and Robiquet, but by many authors, down almost to the present time, that this crystalline body which they had obtained was the only efficient dye-stuff contained in madder or its extracts. In consequence of this arose the practice of calling any preparation of madder by the name alizarine, just as we would call all sorts of wines, brandies, beers, and the like, alcoholic beverages, if we believe the alcohol to be their only efficient constituent.

Thus, as various processes were devised for preparing what may be properly called madder extracts—that is, extracts obtained from madder root, and containing, as was supposed, simply alizarine in a state of greater or less purity, these were naturally called alizarines; but we now know that their efficiency as dyestuffs actually depended upon the presence in them of other dyeing matters besides

alizarine, yet they may still without impropriety be designated alizarines, since this word, by its derivation, really includes the entire material of the madder root, although in works of pure chemistry the word may be set apart and assigned exclusively to the pure crystallizable substance whose formula is C_{14} H_8 O_4.

When Graebe and Liebermann had produced, not as an extract from anything, but built up by an entirely new chemical process of construction from crude elements, a body which they found to be a good substitute as a dyestuff to the existing madder extracts, they also called it alizarine.

Q. 8. What authority have you for the statement that Graebe and Liebermann considered their artificial alizarine as a substitute for the existing madder extracts?

A. On the 27th of January, 1869, Gustave Shaeffer read before the "Societé Industrielle," at Mulhouse (which is, as its name implies, not so much a purely scientific body as an industrial one, being largely composed of manufacturers of various kinds, including calico printers) extracts from a letter received from Liebermann, in which occur the following expressions: "I am able to "confirm the truth of the news which you have received in
616 "regard to artificial alizarine. After a year of work, and "after having indicated theoretically the results which we "wish to obtain, we have at last prepared artificial alizarine, which, "by dyeing, gives the same results as madder."

This appears in the bulletin of the above-named society, 1869, page 46.

Q. 9. What are the characteristic results obtained by dyeing with madder?

A. With a strong alumina mordant it yields a rich red, and with a light alumina mordant, a pink; with a weak iron mordant, a violet; and with a strong iron mordant, a black. The reds and pinks, however, are the colors universally recognized as characterstic of madder colors.

Q. 10. What do you understand to have been the meaning of Liebermann when he states in the extract you have just quoted that artificial alizarine by dyeing gives the same results as madder?

A. I think the words themselves very clearly express that he found the artificial alizarine when used with alumina mordants yielded reds and pinks, and with iron mordants, violets and blacks, similar in appearance to those he obtained with madder.

Q. 11. Referring to complainants' patent reissue No. 4321, please state whether or not, in your opinion, any person skilled in the art or science to which it relates would be enabled by following the description therein to make and use the invention described and claimed in that patent?

A. They would.

Q. 12. Have you manufactured the article described and claimed

in said patent called therein artificial alizarine, by the methods set forth in it?

A. I have, a great number of times.

Q. 13. Please produce some of the artificial alizarine so manufactured by you, and please state when the same was made?

A. I produce some; it was manufactured by me some time last month.

(Counsel for complainant offers in evidence the phial and contents just produced by Prof. Morton, and the same is marked "Complainants' Exhibit Morton No. 1, Aug. 12th, 1876; R. E. S., Exam'r.")

Q. 14. Would or would not, in your opinion, any difficulty be found in practically carrying out and applying to use in the arts the invention described and claimed in complainants' patent by the means or process set forth in it?

A. There would be no difficulty. Being obliged to work on small quantities at a time, there have been made in my laboratory at least as many as fifty batches of artificial alizarine, and, I think, without a single failure.

617 Q. 16. Have you examined any of the contents of the bottle, Compl'ts' Exhibit C, for the purpose of ascertaining what those contents are; and if yea, what do you find the same to be?

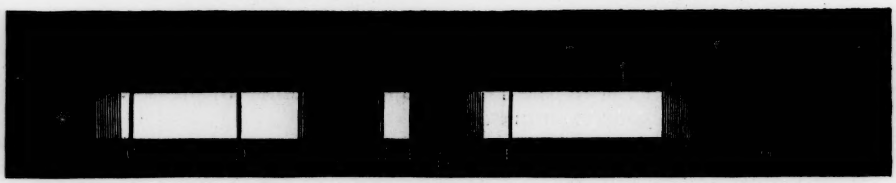
A. I have examined it, applying numerous tests, and find it to be the artificial alizarine described in complainants' patent.

Q. 17. Have you examined the artificial alizarine of complainants' patent, and also extracts of madder, with a view of determining, as far as possible, the exact constitution of each, and the efficiency, as dyeing elements, of their various constituents, if such were found to exist in them? If you have done so, please state the results of your examination?

A. As I have already stated in a previous answer, I have made careful separations of madder preparations, or, as they may be well described, commercial alizarine, into its principal constituents, and have also made a similar separation of artificial alizarine, the subject of complainants' patent. I find that commercial alizarine, as found, for example, in Pincoffin, green alizarine and yellow alizarine, consists essentially of two available dyestuffs, one of them being the pure alizarine, whose formula is assumed to be $C_{14} H_8 O_4$; and purpurine, whose formula is assumed to be $C_{14} H_8 O_5$. The first of these substances, I believe, that I have obtained in a pure state, by following out a process described by Rosenstiehl, involving, among other things, the heating of the substance—commercial alizarine—for about ten hours in a steam boiler, under a pressure of 250 pounds to the square inch, subsequent solutions, crystallization and sublimation. When so prepared the body presents all the characteristics ascribed to pure alizarine; but when used as a dyestuff it fails entirely to give good reds and pinks, and, as these are the colors which are the most valuable and characteristic

tints produced by madder extracts or commercial alizarines, this body is evidently not a commercial substitute for or equivalent of such madder extracts.

In the second place, I find that the madder extracts contain, as I have said, purpurine, which, likewise, by prolonged treatment founded on the processes described by Schützenberger and others, I have obtained in a condition of purity. It then agrees in its properties with the description given by standard authors of this substance, and with alumina mordants produces very brilliant scarlet and orange pink colors. This substance purpurine has besides, two optical properties very valuable as affording means for its recognition. When dissolved in a strong solution of alum it gives an orange red liquid, which fluoresces strongly with a rich green color. This property was first noticed by Prof. Stokes, and is manifest in this way: If a tube or bottle containing such solution is looked at from the side on which the daylight strikes it, it will appear opaque and of a green color; while, seen from the
618 other side, it appears perfectly transparent and of an orange red color. Exhibit Morton No. 2 is such a solution of purpurine in water containing alum. The second optical property is the following: If the light, transmitted through a solution of purpurine in alum water as above, is viewed through a spectroscope, the spectrum or strip of graduated colors is seen to be crossed by two dark shaded bands, located as shown in the drawing Exhibit 3:



(The woodcut made from Exhibit 3, here introduced, represents the appearance and position of the absorption bands A and B, above referred to. The scale at the upper part of the figure is that introduced by Bunsen and Kirchhoff, for purposes of comparison. The long horizontal band represents the spectrum, colored red to the left, and so passing through crimson at C, orange at D, then yellow, then green, extending each side of E and *b*, then blue at about F, and then blending into indigo and violet toward the right. The sharp vertical lines C, D, E, *b*, F, and G, are known as Fraunhofer lines, and belong to the sunlight by which the spectrum is produced. Were the solution of purpurine not present the broad bands, marked A and B, would be absent, but the others would still remain. These Fraunhofer lines are perfectly fixed in position, and are very valuable as means and standards of measurement.)

(Counsel for compl't offers in evidence the purpurine solution and the drawing referred to by the witness, and the same are

marked respectively "Exhibit Morton No. 2," and "Exhibit Drawing No. 3, Aug. 12th, 1876; R. E. S., exam'r.")

The witness continues:

A, B, on said drawing, indicate the positions and character of these bands. No such bands, under the conditions named, are produced by alizarine or any of the other substances, other than purpurine, found in madder extracts, nor are any such bands produced by artificial alizarine as a whole or by any of the different bodies into which I have separated it. I now introduce a bottle containing a solution of purpurine in water containing alum, sufficiently dilute to show these bands with a common pocket spectroscope. This bottle is marked Complainant's Exhibit Morton No. 4.

I also introduce a similar solution made by treating commercial green alizarine with alum water, and this is marked Exhibit Morton No. 5. I also introduce a similar solution from commercial yellow alizarine. This is marked Exhibit Morton No. 6. All of these show the absorption bands above described equally well.

619 I also introduce a specimen of the purified purpurine prepared by me, as hereinbefore described, and crystallized by sublimation, marked Exhibit Morton No. 7; and lastly, for comparison with the above, a specimen of the chemically pure alizarine, also prepared by me, and crystallized by sublimation, marked Exhibit Morton No. 8.

(Counsel for complainant offers in evidence the several exhibits referred to by the witness, and the same are marked respectively Compl'ts' Exhibit Morton Nos. 4, 5, 6, 7, and 8, Aug. 15th, '76, R. E. S., exam'r.

Passing now to the composition of the artificial alizarine, the subject of complainant's patent, I have examined it in the methods described by Herkin in the Journal of the Chemical Society—London, 1873, vol. 26, page 425, and also by the methods of Auerbach, published by Kopp, in the Moniteur Scientifique, 1872, page 686.

By such treatment, I find in it—1st. Anthrapurpurine, a body first isolated by W. H. Perkin, as stated above, and named by him anthrapurpurine; 2d. Isopurpurine, a body first isolated by Auerbach, as stated above, and named by him isopurpurine. These, moreover, are present not as slight traces or insignificant impurities, but in large proportions, varying from 30 to 60 per cent. It is my belief that to their presence the artificial alizarine owes its efficiency as a dyestuff. By a proper regulation of temperature and the amount of soda or potash, their proportion in the material may be so increased as to render it a scarlet rather than a crimson dye, and this fact adds greatly to the value of the artificial alizarine for many purposes.

Q. 18. To what do you refer in your last answer, where you say that by a proper regulation of temperature and the amount of soda or potash, the proportions of anthrapurpurine and isopurpurine in artificial alizarine may be increased?

A. I have been informed that in the manufacture of artificial

alizarine on the large scale. those grades of artificial alizarine which give the more scarlet shades, and which are found to contain the largest proportion of these bodies, are produced at the higher temperature, and with the larger quantities of the alkalies, and I have found a similar result to follow in my own experiments. The patent of complainants giving only general directions that the temperature is to be between 180° and 260° centigrade, I experimented at various temperatures between these two, with amounts of alkalies varying from two to three times the weight of the bibromanthrachinone, as directed in the patent, with the results above described.

Q. 19. Did you find any other substance besides those you have mentioned in artificial alizarine?

A. I found a yellow material corresponding in its behavior with that which has been named in accordance with the chemical
620 theory of its constitution ; monoxanthrachinone. It is separated from the artificial alizarine by converting the whole into a lime lake, and washing with hot water, which removes this substance as a reddish solution from which hydrochloric acid precipitates it as a yellowish powder. Artificial alizarine, according to various authors, contains a number of other products in various quantities, but I have not attempted to separate them.

Q. 20. Are these substances which you have mentioned as existing in artificial alizarine, namely, anthrapurpurine, isopurpurine, and monoxanthrachinone found in madder or in any of its preparations, or in any other dyestuffs, excepting in artificial alizarine?

A. They are not found ; although madder, which is the likeliest substance to contain them, has been elaborately studied by the ablest chemists for many years. It is, indeed, my opinion that no such bodies existed until they were produced by Graebe and Liebermann, by their process described in complainants' patent.

Q. 21. Are these substances which you have isolated from artificial alizarine, namely, anthrapurpurine, isopurpurine, and monoxanthrachinone, the only ones contained in it?

A. They are not. There are contained in it in addition,

1st. Pure alizarine, whose presence in it was first recognized by Graebe and Liebermann, and which was first described by them in the Proceedings of the German Chemical Society of Berlin, 1869, page 14, and also further discussed in a subsequent paper published in the same volume, pages 232, 234.

2d. Anthraflavic acid, first isolated by Edward Schunck, and described by him in the Chemical News, April 6, 1871, vol. 23, p. 157.

3d. Also an orange-dyeing matter, first noticed by Perkin, and mentioned by him in his paper, in the Journal of the Chemical Society, London, 1873, p. 425.

4th. There are also present other substances, whose action in the dye-bath has not yet been studied.

5th. And finally, we find as impurities, properly so called, small

quantities of anthracene, anthrachinone, and traces of mineral matter.

Q. 22. You have stated that the presence of pure alizarine in the artificial alizarine was first recognized by Graebe and Liebermann; please state fully what you understand to be the nature of their recognition of this substance at that time, and the history of the subsequent investigation of this substance and of artificial alizarine by them and by other chemists?

A. The artificial production of a substitute for madder as a dyestuff had been for many years a subject of investigation on the part of many eminent chemists, among whom we may name Laurent, Martius and Griess, and others.

621 In course of his investigations of a class of bodies known as the chinones, (remarkable for their tendency to produce derivatives, having tinctorial properties,) Graebe extended the range of bodies coming within that class from the benzole derivatives into the derivatives of naphthaline and toluol, and after this, together with Liebermann, he was led to believe that alizarine belonged to the chinone series. To test this idea they sought to reduce alizarine so as if possible to find out to what radical it was related. By heating it with zinc dust they obtained a body possessing all the properties of anthracene, and were thus led to the conclusion that it was a chinone derivative belonging to this radical. Having thus obtained a knowledge, never before possessed, of the chemical structure and relations of alizarine, they were stimulated to attempt what had been so often essayed in vain, namely, the artificial construction of this body. It should be here remarked that Colin and Robiquet had isolated from madder one of its dyeing elements, which they, and most chemists for a long time after them, believed to be the only important dyeing element in madder, and to this they gave the name alizarine. By a series of processes, Graebe and Liebermann obtained a complex product in the form of a paste, from which, by sublimation, they obtained a crystalline material corresponding essentially in its general properties with the alizarine obtained from madder by Colin and Robiquet. In a chemical point of view this was the crowning triumph of their labor. They had discovered the true chemical relationship of alizarine, and had reproduced it by artificial means. To confirm and establish this discovery as a fact in chemistry, they made analyses of the sublimed crystalline extract from their product and of a similar sublimed extract from madder, and obtained results according, within the usual limits of such work, and similarly agreeing with their theoretical formula as to the constitution of the extracted bodies. We now know that the methods pursued by them for purifying both these extracts were by no means perfect, and that their extract from their new body must have contained anthrapurpurine, isopurpurine, anthrachinone, and monoxanthrachinone, though by their methods (i. e., extraction by sublimation) the greater part of these substances is destroyed, as also more or less alizarine. The pres-

alizarine on the large scale. those grades of artificial alizarine which give the more scarlet shades, and which are found to contain the largest proportion of these bodies, are produced at the higher temperature, and with the larger quantities of the alkalies, and I have found a similar result to follow in my own experiments. The patent of complainants giving only general directions that the temperature is to be between 180° and 260° centigrade, I experimented at various temperatures between these two, with amounts of alkalies varying from two to three times the weight of the bibromanthrachinone, as directed in the patent, with the results above described.

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621 In course of his investigations of a class of bodies known as the chinones, (remarkable for their tendency to produce derivatives, having tinctorial properties,) Graebe extended the range of bodies coming within that class from the benzole derivatives into the derivatives of naphthaline and toluol, and after this, together with Liebermann, he was led to believe that alizarine belonged to the chinone series. To test this idea they sought to reduce alizarine so as if possible to find out to what radical it was related. By heating it with zinc dust they obtained a body possessing all the properties of anthracene, and were thus led to the conclusion that it was a chinone derivative belonging to this radical. Having thus obtained a knowledge, never before possessed, of the chemical structure and relations of alizarine, they were stimulated to attempt what had been so often essayed in vain, namely, the artificial construction of this body. It should be here remarked that Colin and Robiquet had isolated from madder one of its dyeing elements, which they, and most chemists for a long time after them, believed to be the only important dyeing element in madder, and to this they gave the name alizarine. By a series of processes, Graebe and Liebermann obtained a complex product in the form of a paste, from which, by sublimation, they obtained a crystalline material corresponding essentially in its general properties with the alizarine obtained from madder by Colin and Robiquet. In a chemical point of view this was the crowning triumph of their labor. They had discovered the true chemical relationship of alizarine, and had reproduced it by artificial means. To confirm and establish this discovery as a fact in chemistry, they made analyses of the sublimed crystalline extract from their product and of a similar sublimed extract from madder, and obtained results according, within the usual limits of such work, and similarly agreeing with their theoretical formula as to the constitution of the extracted bodies. We now know that the methods pursued by them for purifying both these extracts were by no means perfect, and that their extract from their new body must have contained anthrapurpurine, isopurpurine, anthrachinone, and monoxanthrachinone, though by their methods (i. e., extraction by sublimation) the greater part of these substances is destroyed, as also more or less alizarine. The pres-

ence of the first two would tend to make the analysis show a deficiency of hydrogen and carbon, while the presence of the last two would develop an excess of these. This tendency to balance would therefore keep the results within the usual limits of error, even if very appreciable quantities of all were present. As soon as this new dye-stuff began to be manufactured, and came into the hands of chemists at large, it began to be investigated, and one after another, various bodies which it contained were recognized. These researches were made by Perkin, Auerbach, Graebe and Liebermann themselves, Schunck, Koechlin, Rosenstiehl, and others, and have so far resulted in the discovery and separation of the various definite compounds, such as isopurpurine, anthrapurpurine, etc., which I have already mentioned. The subject is, moreover,
622 by no means exhausted at the present time, for we find in the "Berichte der Deutchen Chemischen Gesellschaft zu Berlin," for 1876, a discussion going on between Messrs. E. Ulrich and H. von Perger on the one hand and E. Schunck and H. Roemer on the other as to priority of discovery of two new substances, which they have found in the artificial alizarine of Graebe and Liebermann.

Q. 23. Is the sublimed crystalline body, mentioned in your last answer, described or mentioned in Graebe and Liebermann's patent, either in their original patent or their reissue No. 4321?

A. It is not. On referring to their original patent, No. 95465, we find as follows: "We collect the yellow flocks of alizarine, thus obtained, on a filter, and wash them with water. By these methods we receive the alizarine in a form in which it can be employed, in the same manner as the different preparations from madder."

It is worthy of note that they here expressly stop the description of their process at the point where the entire product of the reaction is present, and where, consequently, it is as they say, in a state "in which it can be employed in the same manner as the different preparations of madder." In order that they should have described the crystalline sublimed extract, which they supposed to be identical with the madder alizarine of Robiquet and Colin, it would evidently have been necessary for them to have stated further that the yellow flocks, after being washed, were to be dried and then sublimed. It is a matter which cannot escape the notice of any one experimenting with artificial alizarine, that even by merely drying the product at the boiling point of water, its effects as a dye stuff is modified in a very marked degree. It is for this reason that from the first it has never been put into the market otherwise than as a paste, and the sublimation, requiring a far higher temperature, produces a still more marked change. That Graebe and Liebermann were aware of this is perfectly evident from the expressions in their patent above quoted, and it thus appears that they intended to designate by this expression, the entire product of their process, which was an available substitute for madder, and not that single

element of its composition, which was chiefly interesting from the point of view of theoretical chemistry.

Q. 24. Having reference to the investigations described by you in answer to question seventeen, please state to what conclusions they lead you as to the similarity or dissimilarity of the artificial alizarine of complainants' patent and madder extracts or preparations; please give your reasons for your conclusions?

A. The result of these experiments is to convince me that while madder extracts or commercial alizarines and artificial alizarine contain as one of their constituents a body such as I have described under the name of pure alizarine, which may very probably be identical in all of them, yet this by no means constitutes
623 their only or chief efficiency as practical dye stuffs, but if alone, would be worthless in the most important cases, and that while madder and its preparation owe their practical value to the coexistence in their composition of purpurine, which has been proved to be an essential element, and various other materials, whose effect in the dye bath has not yet been fully investigated, the artificial alizarine owes its efficiency to the coexistence in its composition of anthrapurpurine and isopurpurine, and this in no insignificant quantity, but as a large constituent, not to mention monoxanthraquinone, anthraflavic acid, and Perkin's orange matter and other substances, whose influence in the dye bath has not yet been settled, though there can be no doubt that such an influence exists, and is practically important.

Q. 25. What is alizarine, in the sense in which that word is used in the patent of complainants?

A. Having reference to the word in connection with the preliminary directions of the patent, I should say that it implies a substance produced by the process described therein—that is to say, built up as it were from compounds less complex than itself by chemical reactions, involving none of the peculiar processes characteristic of animal or vegetable life, but capable of replacing as a dye stuff the ordinary alizarines or madder extracts.

Q. 26. Could the description of the invention in complainant's patent be understood as applying to or embracing the production of a substance already known at the time they made the invention?

A. It could not. It describes a process which I have repeatedly carried out with the production of a product containing, as essential constituents, substances which I do not believe to have existed, and which were certainly unknown prior to this invention; and it is to the presence of these substances that the new product owes its practical efficiency and value as a dye-stuff.

Q. 27. Having in view the state of the art at the time of the grant in this country of letters patent to Graebe and Leibermann, for this invention, do you regard their description of their product as correct?

A. I do. These inventors had made an essentially new dye-stuff,

which they found to be an efficient substitute for preparations of madder, and capable of taking their place in the ordinary operations of dyeing and calico printing.

The body described, being a new composition of matter, whose properties, with the exception of its action as a dye-stuff, had been only partially investigated. It was best defined as being the product of a process which, as we have seen, cannot fail to produce the new substance, which is the subject of this patent. It was not until several years spent in investigation by the ablest chemists that the true composition of this new dye-stuff was even partially recognized, and even at the present time the subject is far from being exhausted.

624 Q. 28. Do you consider the alizarine described in the patent to be the same thing as the pure alizarine whose formula is $C_{14} H_8 O_4$.

A. Certainly not; it cannot be represented by any formula. As I have already said in previous answers the artificial alizarine of complainant's patent contains, besides pure alizarine, large and practically essential quantities of other drying matters, such as anthrapurpurine and isopurpurine, to say nothing of monoxanthrachinone, and several other substances whose practical relations in the dye bath are not yet well understood.

Q. 29. Are your statements in previous answers, as to the composition of artificial alizarine, supported by the publications of standard authorities, and if so please quote some of these corroborative publications?

A. My statements are, I believe, fully confirmed by the highest authorities, as I will now show.

The first to separate out or isolate anthrapurpurine was the well known English chemist, W. H. Perkin. In 1870, even while he was still under the impression that the pure alizarine was the only efficient dyestuff in madder, he nevertheless states (see Journal of the Chemical Society of London, 1870, vol. 23, page 143): "Artificial alizarine, as supplied to the dyer and printer, is not chemically pure, and usually produces, with aluminum mordants, colors somewhat redder than madder. It has been stated that this is due to the presence of purpurine; this, however, is not the case, as none of this coloring matter can be detected even by Prof. Stoke's test (the fluorescent appearance)." Dr. Shunck has also confirmed this.

In a foot-note to the above, Perkin remarks: "When purifying artificial alizarine by converting it into an alumina lake, I found that upon digestion with carbonate of potash, this lake gave a red colored solution containing a coloring matter, dyeing mordants very similarly to alizarine, with this difference that the reds are more scarlet and the purples bluer or more slaty. I have not obtained this body in a perfectly pure state as yet, but it appears to be crystalline."

We have here a publication of the first partial separation of anthrapurpurine from the product of Graebe and Liebermann.

In 1872, in vol. 25 of the same journal, on page 659, he gives an analysis of the same substance and a formula $C_{14}H_8O_5$; and furthermore says: "This formula is the same as that usually assigned to "purpurine. The substance is, however, entirely different in its "properties from that coloring matter; for example, its etherial "solution does not give the characteristic bands when examined "with a spectroscope, nor does it form the pink fluorescent solu- "tion when boiled with a solution of alum. It also dissolves in "alkalies, with a violet color, not a red.

"It also differs from alizarine in many ways. Its solution in "caustic potash is not of such a blue violet, although it gives
625 "two bands when viewed with the prism, similar to those of "alizarine but not so marked. It dissolves in ammonia "with a red purple color, and this solution gives no bands, whereas "alizarine dissolves with a blue violet color, and gives two bands. "Its ammoniacal solution, when added to aluminate of potash, "produces no precipitate; an ammoniacal solution of alizarine "gives a red lake usually at once, but always after standing for "some time.

"This coloring matter is, therefore, distinct, both from alizarine "and from purpurine."

In 1873, he had completed his examination and numerous analyses of the substance, and in vol. 26 of the same journal, page 425 et seq., he publishes a complete discussion of the new substance, for which he proposes the name anthrapurpurine. Attached to this paper are specimens of calico dyed with anthrapurpurine, and with pure alizarine. On page 425, he says as follows:

"Commercial artificial alizarine, when introduced as a dyeing "agent, was generally supposed to contain purpurine, owing to the "pureness of the red colours it produced with alumina mordants; "but in a paper which I had the honour of reading before the so- "ciety some time since, this idea was shown to be incorrect. In "the same paper, however, the existence in this product of a col- "ouring matter differing from alizarine was pointed out. I have "been for some time experimenting with this substance, and in "August last brought a short account of it before the society; I "now beg leave to give a more detailed account of the results I "have obtained in its examination.

"To obtain this substance, which I propose to call anthrapurpu- "rine, from commercial artificial alizarine, I have tried various "methods. * * * * * The anthrapurpurine thus obtained "is very impure, being associated with a substance dyeing alumina "mordant of an orange colour,* as well as anthraflavic acid, etc."

On page 433 he says as follows:

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* "This is under investigation."

"*Anthrapurpurine as a Dyeing Agent.*

" This substance has about the same affinity for mordants as ali-
" zarine. The colors it produces are also analogous to some extent,
" as it produces red with alumina, purple and black with iron
" mordants. There is, however, a considerable difference in the
" shade of color produced, the reds being much purer and less blue
" than those of alizarine, whilst the purples are bluer and the
" blacks more intense. The fastness of the colors against soap and
" light, are quite equal to those produced with alizarine.

" When used to dye turkey red, it produces very brilliant colors
" of a scarlet shade, which are of remarkable permanence.

" The patterns attached to this paper are only amateur produc-
" tions; if dyed on the large scale, the colors would probably
626 " be purer, but they serve to illustrate the difference between
" the shade of color produced with anthrapurpurine and
" pure alizarine."

In 1872, in the Moniteur Scientifique, pages 686 and 687, I find an abstract by E. Kopp, of a research by Auerbach, entitled "Sur l'isopurpurine produit extrait de l'alizarine artificielle," in which he gives a full account of the method by which he separated from artificial alizarine a substance resembling purpurine, although entirely different from it in many important particulars. On page 687, he says:

" On mordanted cotton, isopurpurine gives tints resembling those
" of purpurine; the reds and pinks approach scarlet; the violet is
" brownish; the browns and blacks are strong. These colors re-
" sist boiling soap well. The small portion of the baryta lake
" which is not dissolved in water, having been decomposed by hy-
" drochloric acid, we can isolate from it a coloring material which
" presents all the properties of alizarine, properly so called. By
" a sufficiently large number of reactions, isopurpurine differs from
" purpurine, and these two substances cannot be considered as iden-
" tical. The fact of the artificial production of a coloring mate-
" rial having the same composition, and most of the tinctorial pro-
" perties of purpurine, is not not only very important from the
" practical point of view, but also very interesting from that of
" theory."

Again, in the " Handbuch der Chem. Technologie," by Dr. P. A. Bolley and Dr. H. Birnbaum, 1874, vol. 3, page 409, in an article entitled "A Treatise on the Artificial Production of Organic Dyestuffs," by Dr. E. Kopp, we have as follows:

" *Methods for the Production of Artificial Alizarine.*

" The history of these methods for producing, shows most clearly how the most difficult and expensive reactions applied at first, were gradually simplified, and how, step by step, the very expensive reagents were substituted by cheaper ones, without impairing in the

least the good quality and purity of the product." Again, on pages 418 and 419, we have as follows under the title:

"'Properties of the Artificial Alizarine.' The manufacture has made such progress that the principal manufacturers can supply at this time several varieties of artificial alizarine according to demand; for instance, Gessert, at Elberfeld, supplies alizarine of yellow shade and alizarine of blue shade. The alizarine yellow shade is principally used for dyeing and printing reds. On account of the purity of this dyestuff, the colors yielded by it are also immediately clear, and after a slight soaping, they far surpass in brilliancy the colors produced with madder and garancine. The yellowish tinge, while shading the color a little scarlet, enhances the beauty of the red. The alizarine blueish shade is used in producing violets and lilacs, and replaces favorably, madder flower and Pinkoffin.

627 "Dyeing tests made with dry alizarine and with alizarine in paste, corresponding exactly to amount of dry coloring matter, have shown a considerably smaller yield of color, with the dry product."

On page 534, we find as follows: "That artificial alizarine may contain a larger number of compounds than one was formerly disposed to accept, is proved by the presence of anthrapurpurine isolated by Perkin, besides oxanthraquinone, anthraflavone, isopurpusine, &c."

And on page 535, we find as follows: "Anthrapurpurine dyes the various mordants for the same colors as easily and fast as alizarine. But the shades are different, the reds are more brilliant and purer, being less bluish; the lilacs are more blue, and the blacks much fuller and more intense.

"On cloth prepared for turkey-red, the anthrapurpurine yields a brilliant, very solid (fast) scarlet red."

In the report of the Vienna Exhibition of 1873, p. 26, by Graebe and Liebermann, I find as follows:

"As has already been stated in the introduction, there is always produced in the fusion of the anthrachinone sulpho-acids with caustic soda, besides alizarine, a dyestuff having the same composition as purpurine in greater or less quantities. As a consequence of this, it is also contained in varying quantities in commercial alizarine; in the smallest quantity, in the alizarine for violets, most abundantly in the alizarine for red. It cannot be called a bi-product, because for the production of certain red shades, it has advantages even over alizarine."

In the "Moniteur Scientifique" for 1869, on pages 874 and 875, I find a letter to the editor of the above journal from M. Camille Koechlin, of Mulhouse, which I translate as follows: "I have the satisfaction to announce to you that the artificial alizarine which you have sent me has yielded on trial colors superior to those of madder and to its commercial derivatives. These colors exhibit new qualities. They differ from those of purpurine, and fortunately have nothing

in common with those of alizarine. The reds are more scarlet, the chocolates are richer, the iron mordants are better dyed. It is madder under a new constitution, uniting at once and in a marvelous manner the qualities of alizarine with those of purpurine, with one exception only, in reference to the pinks, which incline to yellowish, a question of perfection for the developing of alizarine.

"Although this synthetic rival, which comes from the factory of Messrs. Meister-Lucius, is not for sciences the alizarine of the alizaris, a coloring matter which is produced at a low temperature, it is for industry infinitely more than that alizarine; it is the madder of the future, and by general consent it is the solution of the problem of Laurent. The alizarine, or rather the artificial mad-
628 der of Meister-Lucius, is in the state of a paste which represents five times the tinctorial power of madder. By sublimation it yields needles shorter and paler than those of alizarine, and which give, with the alkaline reagents, the coloration proper to purpurine, while at the same time it is not purpurine."

On page 914 of the same volume I find a series of specimens or swatches illustrating the comparative tinctorial properties of certain dyestuffs which are described on the back of the same leaf or page 913, as follows:

"Colors of strong tint obtain for comparison with the following coloring matters: 1, artificial alizarine of Messrs. Meister-Lucius & Co., at Hoechst, near Francfort; 2, madder; 3, garancine; 4, natural alizarine sublimed; 5, purpurine sublimed. For the information of those who are not familiar with the processes of dyeing, we state how the five different tints which are seen on each strip of the colored materials 1, 2, 3, 4, 5 are obtained. Each band, except the little separation which has remained white, is mordanted in a cylinder *ad hoc*. The first color, which is found at the bottom of the page, and which is black, by a concentrated solution of iron; the second color, following upwards by a solution of alumina and of iron concentrated; the third, with a concentrated solution of alumina; the fourth, with a dilute solution of alumina, and the fifth, with a diluted solution of iron.

"The strip of cotton thus prepared is placed in the dyebath from 45 to 100 degrees, and the five colors are developed.

"Passed thereupon into a bath of boiling soap, the mordanted parts are cleared, and the parts not mordanted, the little white bands of which we have spoken, become colorless, madder having no affinity for cloth which is not mordanted."

Continuing, on page 915, we read: "These irrefragable witnesses declare that artificial alizarine is neither alizarine nor purpurine, but a new compound, superior for our purposes to the derivatives of madder. Although these are thus menaced with a speedy end, and have given cause during their existence to more researches and publications than any other coloring matter, I will, nevertheless, review some of the characteristics of the coloring matters of the Rubiaceæ.

"The coloring matter of the madder colors is a mixture: 1, of alizarine and purpurine in varying proportions, according to the cultivation and to the species of salts whose assimilation this cultivation has favored. Where the soil is calcareous, one part of the coloring matter, sometimes more than half, is united with the lime, and this part destroyed for dyeing purposes is first taken from the purpurine. For this reason those madders are richest in purpurine which are cultivated in the ground containing least lime. The madder containing most purpurine yields orange shades, while the madder in which purpurine is held latent by a base dyes more of a carmine color on account of the alizarine. Purpurine is a stronger acid than alizarine; it displaces it from its combinations, and even prevents it from dyeing if present in sufficient quantities. On its part, purpurine does not give fast colors, unless it is associated with alizarine, or has been sublimed or exposed to a temperature of 200° C, a temperature which is not far removed from that at which artificial alizarine is produced. Purpurine alone does not resist boiling soap, while alizarine alone or alizarine with purpurine do resist." In a recent work entitled "A Manual of Dyeing and Dyeing Receipts," by James Napier, London, 1875, I find as follows, on pages 335 and 336:

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"Wherever the artificial colors can be produced and sold to the dyer at a price lower than the natural, the latter must yield. Notwithstanding this, artificial alizarine will not put madder quite out of the market; for the latter is preferable for many colors upon wool, because it contains other dyes which the wool takes up, giving tints which pure alizarine does not; but further discoveries may soon overcome this difference. The reader will have seen that mauve and magenta were only the first of a series of new dyes, so also may alizarine yet turn out to be; and should there develop from this source a series of colors with the permanency of alizarine, the result will be of greatest importance to the dyeing and calico printing trades. Indeed, we have already indications of such a series. Mr. Perkin has announced that when experimenting upon alizarine he found that there was produced along with that coloring matter another which gave certain reactions differing from alizarine; it gave with the same mordants a bluer purple and a more scarlet red; and to this coloring matter he has given the name of anthrapurpurine and its formula is $C_{14} H_8 O_4$. He separated this anthrapurpurine from crude (artificial) alizarine, by dissolving the latter in a dilute solution of carbonate of soda, and adding precipitated alumina, which on agitation combined with the alizarine, forming a lake which precipitated and left the anthrapurpurine in solution; he boiled this clear solution and acidified with hydrochloric acid, which caused the coloring matter to be precipitated. Mr. Perkin says this coloring matter is still associated with another which gives an orange color with aluminous mordants. By repeated boiling in alcohol, this orange coloring can be removed from the anthrapurpurine. These processes of separation are yet

difficult but hopeful; the orange coloring matter has not yet been subjected to analysis. The following are some of the properties and reactions of anthrapurpurine: it is very slightly soluble in water; caustic potash and soda dissolve it, giving beautiful violet colored solutions, which become blue when heated, but not so blue as those obtained with alizarine; it dissolves also in solutions of the alkaline carbonates, giving a reddish purple color, which is precipitated with carbonic acid. If a solution of it in alcohol have acetate of copper added, the color changes from a yellow to a beautiful purple. When an ammoniacal solution of it is acidified with hydrochloric acid, the dye is precipitated as a dark purple, which dissolves in carbonate of soda, yielding a blue color and in caustic alkalies yielding a reddish purple. Mr. Perkin says that anthrapurpurine has about the same affinity for mordants as alizarine; the colors it produces are also to some extent analogous, for it dyes red with alumina, purple and black with iron mordants. There is, however, he observes, a considerable difference in the shade of color produced, the reds being much purer and less blue than those of alizarine, and the purples, blues and blacks more intense. The fastness of the colors against light and soap is equal to that of the alizarine colors. When used in dyeing turkey-red, it produces very brilliant colors of a scarlet shade, which are remarkable for their permanence."

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Again, in the second supplement of Watt's Dictionary of Chemistry of 1875, on page 41, I find as follows:

"Red color printing with artificial alizarine.—A. Muller (Chem. Centralblatt, 1871, 304) obtains a red similar in tint and purity to turkey red, from anthracene-alizarine by a process of direct printing.

"The pigment (containing much anthrapurpurine) in a pasty form, and having 25 per cent. of dry material, is dissolved in boiling spirit, etc."

On page 89 of the same work we find as follows:

"As a dyeing agent anthrapurpurine has about the same affinity for mordants as alizarine. The colors it produces are also analogous to some extent, as it produces red with alumina, purple and black with iron mordants. There is, however, a considerable difference in the shade of color produced, the reds being much purer and less blue than those of alizarine, whilst the purples are bluer and the blacks more intense. In fastness against soap and light the colors are quite equal to those produced with alizarine."

Indeed, it seems to me impossible that any question on this subject can be seriously entertained when the most important researches in connection with this subject are those which have developed the existence and properties of such important coloring principles as anthrapurpurine and isopurpurine. Before these researches were made, it was, of course, natural for writers who did not as yet know of the existence of these bodies, and were not even led to suspect their existence through want of practical acquaintance with

the behavior of the artificial alizarine as a dye-stuff, to describe the one material which they had recognized; but of course such a description and expression counts for nothing against their own subsequent testimony or that of others, when these substances, anthrapurpurine and isopurpurine, had been recognized in it, separated and experimented with.

Q. 30. You have stated in previous answers that chemically pure alizarine, indicated by the formula $C_{14} H_8 O_4$, is not a practically available dye-stuff, similar in its effects to the commercial extracts of madder; this opinion being founded on your own experiments, will you state what support for this opinion you find in the publications of standard authors?

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A. As early as 1853, in the work entitled "A Manual of the Art of Dyeing," by James Napier, F.C.S., Glasgow, 1853, I find the following:

"From the above reactions of alizarine with other substances, it was supposed that it constituted the true coloring of madder; and means were soon adopted to separate this coloring matter from the vegetable and use it pure; but it was afterwards found that a fixed dye could not be obtained by pure alizarine, and therefore it did not constitute all that was required in giving the dye. This led to further investigations productive of further discoveries respecting these coloring matters. It finally appeared that madder has five different coloring matters, which have been named madder purple, madder red, madder orange, madder yellow, madder brown, each of which may be obtained by the following operations." Here follows a description directing how the substances named above may be obtained, though evidently each of them in a very impure condition.

This view, as to the composition of an available madder dye, though at the early date of its first publication by no means universally accepted, has been in all essential particulars fully confirmed by the many elaborate investigations which have been made by different chemists during the 22 years which have elapsed since this book was published; and in the very latest edition of the same work, entitled "A Manual of Dyeing and Dyeing Receipts," by James Napier, P.R.S.E., F.C.S., etc., London, 1875, we have repeated, on page 289, precisely the same statement, with a single unimportant verbal modification. Among the authors who have elaborately investigated this question is Schutzenberger, who, in the "Moniteur Scientifique" for 1869, in an article on "*The application of Madder Extracts in Calico Printing, and the part played by the different Pigments of Madder*," says:

"Pure alizarine gives very beautiful violets, but the reds are too violet. The fine reds are only obtainable with extracts containing at the same time alizarine, purpurine, and even a certain proportion of the yellow matter, mixed in the proper proportions. On the other hand, these extracts only give dull violets.

"Here is revealed in a very clear manner the influence of the

various madder pigments, of which we have yet to speak. In the actual state of the science, and according to the researches of a great number of chemists, it must be admitted that the pigments of madder, little or not at all soluble in water, pre-exist in the fresh root in the form of glucosides, soluble and easily de-
632 composed by ferments, by acids, and by alkalies. The coloring matters, separated from their glucosides, and whose existence seems to us at the present time placed beyond doubt, are—

"First—Alizarine, discovered by Robiquet and Colin.

"Second—Purpurine, studied by Persoz, Runge, Debus, Wolf and Strecker, and myself.

"Third—Pseudopurpurine } discovered by me in the commercial
"Fourth—Orange matter, } purpurine of Kopp.

"Fifth—Purpuroxanthine or yellow matter, which I have also isolated from commercial purpurine. These pigments, perfectly definite and crystallizable, are distinguished by their physical properties and especially by the absorption bands which they give with the spectroscope, by their solubility in various neutral or alkaline solvents, by their composition, and lastly, by their tinctorial properties."

On page 878 I find as follows:

"*Behavior in Dyeing.*

"Alizarine gives fast colors resisting soap, and nitro-muriate—of a violet red—of a violet very pure.

"Purpurine and orange matter yield fast colors, and resist soap and nitro-muriate sufficiently well; red very brilliant, and violet dull and gray.

"Pseudopurpurine gives shades passing away entirely with soap and nitro-muriate; red clear, but a little bricky; violet pale.

"The yellow matter yields colors moderately fast; orange yellow, with alumina; pale gray, with the iron mordants."

Again, in the "Moniteur Scientifique," 1875, page 562, I find an account by Alfred Naquet, of a research by A. Rosenstiehl, entitled "Researches on the Relations which connect the different coloring matters of Madder, and the part which they play in Dyeing."

The author begins as follows:

"Since the remarkable work of Messrs. Schutzenberger & Schiffert on the Alsace madder, it is admitted that this tinctorial root contains four coloring matters—alizarine, pseudopurpurine, purpurine, and purpurine hydrate; but the part of each of these substances in dyeing is ill-determined, and it is not known which or how many constitute Turkey-red, red, or the madder pink, which, by their brightness and their fastness, are considered the types of good colors. It is this gap which Mr. Rosenstiehl now fills. Mr. Schutzenberger had asserted that these tints were exclusively due to alizarine, and that the purpurine was completely eliminated

during the operations of cleaning and soaping. But in 1867,
633 Mr. Camille Kœchlin has combatted in this respect the ideas of Mr. Schutzenberger. He has demonstrated, in fact, that the purest alizarine obtained so far, that is to say, sublimed alizarine or superheated with water and alcohol, and which are known to-day to contain some purpurine, yields with the iron mordants more beautiful violets than madder, but is incapable of giving good reds with the alumina mordants."

Passing to the foot of page 563, we find as follows:

"*Concerning the preparation of Pure Alizarine and its Tinctorial Properties.*

"Before the discovery of artificial alizarine, various madder extracts were used for the preparation of this body; among these, recently, the green and yellow alizarine, prepared from Alsace madder by the process of Mr. Kopp. Unfortunately, this alizarine—green or yellow—contains purpurine which the recommended methods of purification do not enable us to remove. Mr. Stenhouse first recognized this impurity, and Mr. Stockes has, a little later, estimated the proportion of purpurine at 30 per cent. of the entire mass. It is evident that, with such a starting point, all the analyses and all the descriptions must be erroneous, and we can see how, when the discovery of Messrs. Graebe and Liebermann was made, the identity of the red madder, which they had obtained with alizarine, was doubted, since the properties did not seem to coincide with those of the artificial product.

"This mistake is more natural, since in the transformation of anthracene into alizarine, there is always formed another coloring matter which changes to a certain degree the tinctorial properties of the first of these bodies.

"In fact, the tints obtained with the alizarine from madder and from the artificial alizarine differ; and if it is true that by purifying one and the other, partly by sublimation and partly by successive crystallizations, these differences are diminished, it is equally true that up to the present time no one has been able to make them disappear entirely. It is only recently that Mr. Rosenstiehl has been able to produce identical shades with the two alizarines by a method which he discovered by chance. This method consists in heating madder alizarine to 200°, in a closed vessel, with an aquious alkali solution. The duration of the contact should vary more or less with the purity of the material which serves at the starting point; with commercial alizarine it should be seven hours. By this operation the purpurine is first destroyed. It forms, it is true, a brown substance and a solid body, which dye cotton a dull blue; but two or three crystallizations remove them.

"We can, however, much more easily and more rapidly arrive at a definite product by taking the artificial alizarine, which
634 should be selected as pure as possible. It then contains as impurities only a little anthrachinone, oxanthrachinone, and

isopurpurine, from which it is easily freed by two or three crystallizations from alcohol, especially if we take care to sublime it previously.

"Pure alizarine, crystalized from alcohol, presents itself in the form of fine yellow needles, or in the form of scales, of which the color is the more orange as they are thicker. At equal dimensions these crystals are always less red than those of alizarine prepared according to the directions of the classical works, and which contain purpurine."

Passing to page 568 of the same article, we find as follows:

"To determine the relative quantities of alizarine and purpurine which are necessary for the production of madder red, Rosenstiehl took two titrated alcoholic solutions, one of alizarine and one of purpurine, and made numerous dyeing tests, with mixtures in various proportions of these two solutions, securing the conditions for maximum—that is to say, by placing in the bath equivalent quantities of carbonate of lime and of the tinctorial matter. He was able to obtain a scale of tints very near together, in which he sought for the tones which came nearest to the beautiful reds and beautiful pinks of madder. He observed that the steps at the purpurine end of the scale (he added 5 per cent. at a time) resembled each other so much that 30 or 40 per cent. of alizarine modified but little the tint of the mixture, while the steps at the opposite extremity of the series differed much more among themselves. The beautiful madder red, which imitates the red of Adrianople, and the beautiful red of the flowers of madder, are produced with the following mixture:

Purpurine.....	55 parts.
Alizarine.....	45 "

That is to say, almost a mixture of the two coloring substances in their molecular proportions. Rosenstiehl, in giving these figures, does not intend to say that the fixed quantity of each material corresponds to the above ratio. Such a conclusion would be hasty; but simply that he obtained beautiful reds in a bath containing alizarine 45 per cent., purpurine 55 per cent."

Again, if we examine the specimen of cloth dyed with sublimed natural alizarine, which is given with four other specimens on page 914 of the "Moniteur Scientifique" for 1869, in the article by Koechlin, which I have already quoted in my 29th answer, we will see that a comparison of the specimen dyed with the sublimed alizarine with the one dyed with the artificial alizarine of Meister, Lucius & Co., bears out the descriptions of the various authors above quoted, namely, the first yields a dull purplish red
635 and a dead grayish pink, while at the same time its violet is peculiarly intense. I have also myself made a number of dyeing tests with chemically pure alizarine, a portion of which I have already introduced as an exhibit, Morton No. 8, and find in every case the same result—namely, dull bluish reds and pinks

with alumina mordants, though a strong violet with iron mordants.

Q. 31. What can you say respecting the novelty of the alizarine described and claimed in complainants' patent Exhibit A?

A. I consider this to be an essentially new dye-stuff, replacing madder and its preparations to a great degree in the arts of dyeing and calico printing.

First.—It is new as to its origin, being a purely artificial production, built up by a process of chemical synthesis from materials none of which contained it, or anything approaching it, in character or properties.

Second.—It is new in its composition, for it contains the substances isopurpurine and anthrapurpurine in large and effective proportions, these bodies being themselves effective dyeing principles, and unknown, and not even existing before the discovery and preparation of artificial alizarine by Graebe and Liebermann.

Thirdly.—It is new in its properties, being capable of producing tints in the processes of dyeing and calico printing which cannot be obtained with the preparations of madder or other dye-stuffs previously known; and also showing a long series of new chemical properties by which these substances, anthrapurpurine, isopurpurine, as well as oxanthrachinone, anthraflavic acid and several others are distinguished and recognized.

I will explain more fully the above-enumerated points of novelty as follows:

First.—As regards the artificial character of the substance:

When coal is subjected in close vessels to intense heat, various reactions take place, causing the formation of an immense series of compounds, among which the chief consist of hydrogen and carbon combined in various proportions.

The coal tar which contains a great number of these, being submitted to a second distillation, yields as one of its products, also at a very high temperature, the body named anthracene, which, when purified, is a white, waxy substance, much resembling in appearance stearic acid, as we find it in our common candles.

Now, it is this sort of colorless wax or grease, which Graebe and Liebermann have built up into their artificial dye-stuff, by a series of chemical treatments in which bichromate of potash, sulphuric acid, bromine and caustic potash or soda, with the assistance of high temperatures, are the effective agents. In this manner they have, step by step, built up, by the addition of atoms and molecules to the anthracene, which was their foundation, that beautiful and complex product, artificial alizarine.

636 It would be hard to imagine anything more completely unlike than is this, to the process by which complex dye-stuffs, formed by the process of natural growth in plants, are extracted therefrom and more or less purified.

Second.—As regards its newness of composition:

As I have already stated, the substances anthrapurpurine and

isopurpurine exist in the artificial alizarine, in effective quantities, which while they vary in different specimens with the variations in temperature and proportions of ingredients employed in their manufacture, amount in many cases to more than 50 per cent. These substances are, moreover, as I have already shown, not only available but very beautiful, and, indeed, in the artificial alizarine *essential* dyeing principles; they are essential to the production of these colors which are the characteristic and most valuable ones obtainable with this dyestuff, artificial alizarine. They have been thoroughly studied by eminent chemists, as I have already shown, and proved to be entirely different from any substances previously known. I have also extracted them myself from the artificial alizarine, and have tested them as dyeing elements, and in reference to their various distinguishing characteristics or properties. Specimens of these substances, and of cloth dyed with them, I will introduce subsequently as Exhibits.

Besides these substances, whose efficiency as dyeing elements has been fully recognized, there are several others present in artificial alizarine, whose properties have not yet received so much attention, but which we have strong reason to believe, exert an important influence when the artificial alizarine is employed in the process of dyeing and calico printing.

Third.—In reference to the newness of properties:

Numerous authorities, whom I have already quoted in my answer to question 29 of this Record, assert most clearly that effects are obtained in dyeing and calico printing with the artificial alizarine which cannot be produced with madder or its extracts, and the researches of Perkin and Auerbach contain long lists of properties and tests by which anthrapurpurine and isopurpurine (essential constituents of artificial alizarine) may be distinguished from all other substances.

Q. 32 Following the directions given by Graebe and Liebermann in their patent, would it be possible to produce a product, not containing in efficient quantities, anthrapurpurine, isopurpurine, and such other substances as you have stated to form essential constituents of the product, as a dyestuff, substituting madder and its preparations?

A. It would not. As I have previously stated in an early answer, I have prepared this product a great number of times, with variations of temperature and proportions as authorized by the patent, and have never failed to obtain a product which, while varying in the proportion of its different constituents, in
637 all cases contain them, as appeared, among other things, by its efficiency as a substitute for madder and its preparations in dyeing. I did not, however, rely upon this test alone, but made separations into the elementary dyeing principles before mentioned in a number of instances.

Q. 33. What has been the result of this invention of Graebe and Liebermann in connection with the industries of dyeing and calico printing?

A. It has produced a practical revolution in these, inasmuch as the artificial alizarine has nearly superseded all the varieties of madder extracts, so that these have been withdrawn from the market, while even madder itself and its simple preparations, such as flowers of madder and garancine are little used in comparison with their consumption in former years, and the cultivation of this plant has been reduced to an insignificant percentage of what it was before, the ground formerly occupied for this purpose being now turned to other uses. It has immensely increased the range of application of topical printing and piece dyeing, so that numberless patterns and styles of goods which before could not have been produced at all, commercially, or only by much slower and much more expensive processes, are now readily manufactured by these means.

In 1871, when the manufacture had only recently commenced, the amount sent into the market was estimated at about 300,000 pounds; in 1872 it was about 1,000,000 pounds, in 1873 about 2,000,000, and at the present time the complainants are manufacturing about 3,000,000 pounds a year, or as a matter of fact, by the latest advices, they are turning out 160 cwt. a day.

Q. 34. Having reference to Dr. Chandler's answers to questions 31 and 32, which are as follows: "Q. 31. What did Graebe and Liebermann discover in this connection? A. They discovered that when the alizarine of madder is submitted to the process of Bayer, that is, heated with zinc-dust, it reveals its parent hydro-carbon, which is anthracene, the body previously discovered in 1832 by Dumas and Laurent. Q. 32. What, if anything, did Graebe and Liebermann invent in this connection? A. Having discovered that alizarine is a derivative of anthracene, they invented a process for producing it from anthracene; alizarine differs from anthracene in containing two atoms of oxygen in the place of two atoms of hydrogen, and two molecules of hydroxyl (OH) in place of two atoms of hydrogen thus—

"Anthracene is C_{14}, H_{10}, and

"Alizarine is $C_{14} H_6 \left\{ \begin{matrix} O_2 \\ (OH)_2 \end{matrix} \right.$; or, $C_{14} H_8 O_4$.

"Graebe and Liebermann employed well known processes for substituting O_2 H_2 and (OH), for H_2, and thus obtained alizarine from anthracene." Please say if you regard this as a fair statement of the discovery of Graebe and Liebermann?

A. I do not. In the first place, the expression, "it re-
638 veals its parent hydro-carbon," tends to convey the impression that anthracene was in some ordinary sense the parent of the alizarine of madder, or in other words, that the alizarine of madder was in some sense derived or produced from anthracene, a statement which would be utterly untrue.

Of the countless tons of alizarine which have been developed in madder root, not one atom was or could have been produced from anthracine.

Secondly.—The description in answer 32 is so worded as to de-

isopurpurine exist in the artificial alizarine, in effective quantities, which while they vary in different specimens with the variations in temperature and proportions of ingredients employed in their manufacture, amount in many cases to more than 50 per cent. These substances are, moreover, as I have already shown, not only available but very beautiful, and, indeed, in the artificial alizarine *essential* dyeing principles; they are essential to the production of these colors which are the characteristic and most valuable ones obtainable with this dyestuff, artificial alizarine. They have been thoroughly studied by eminent chemists, as I have already shown, and proved to be entirely different from any substances previously known. I have also extracted them myself from the artificial alizarine, and have tested them as dyeing elements, and in reference to their various distinguishing characteristics or properties. Specimens of these substances, and of cloth dyed with them, I will introduce subsequently as Exhibits.

Besides these substances, whose efficiency as dyeing elements has been fully recognized, there are several others present in artificial alizarine, whose properties have not yet received so much attention, but which we have strong reason to believe, exert an important influence when the artificial alizarine is employed in the process of dyeing and calico printing.

Third.—In reference to the newness of properties:

Numerous authorities, whom I have already quoted in my answer to question 29 of this Record, assert most clearly that effects are obtained in dyeing and calico printing with the artificial alizarine which cannot be produced with madder or its extracts, and the researches of Perkin and Auerbach contain long lists of properties and tests by which anthrapurpurine and isopurpurine (essential constituents of artificial alizarine) may be distinguished from all other substances.

Q. 32 Following the directions given by Graebe and Liebermann in their patent, would it be possible to produce a product, not containing in efficient quantities, anthrapurpurine, isopurpurine, and such other substances as you have stated to form essential constituents of the product, as a dyestuff, substituting madder and its preparations?

A. It would not. As I have previously stated in an early answer, I have prepared this product a great number of times, with variations of temperature and proportions as authorized by the patent, and have never failed to obtain a product which, while varying in the proportion of its different constituents, in
637 all cases contain them, as appeared, among other things, by its efficiency as a substitute for madder and its preparations in dyeing. I did not, however, rely upon this test alone, but made separations into the elementary dyeing principles before mentioned in a number of instances.

Q. 33. What has been the result of this invention of Graebe and Liebermann in connection with the industries of dyeing and calico printing?

A. It has produced a practical revolution in these, inasmuch as the artificial alizarine has nearly superseded all the varieties of madder extracts, so that these have been withdrawn from the market, while even madder itself and its simple preparations, such as flowers of madder and garancine are little used in comparison with their consumption in former years, and the cultivation of this plant has been reduced to an insignificant percentage of what it was before, the ground formerly occupied for this purpose being now turned to other uses. It has immensely increased the range of application of topical printing and piece dyeing, so that numberless patterns and styles of goods which before could not have been produced at all, commercially, or only by much slower and much more expensive processes, are now readily manufactured by these means.

In 1871, when the manufacture had only recently commenced, the amount sent into the market was estimated at about 300,000 pounds; in 1872 it was about 1,000,000 pounds, in 1873 about 2,000,000, and at the present time the complainants are manufacturing about 3,000,000 pounds a year, or as a matter of fact, by the latest advices, they are turning out 160 cwt. a day.

Q. 34. Having reference to Dr. Chandler's answers to questions 31 and 32, which are as follows: "Q. 31. What did Graebe and Liebermann discover in this connection? A. They discovered that when the alizarine of madder is submitted to the process of Bayer, that is, heated with zinc-dust, it reveals its parent hydro-carbon, which is anthracene, the body previously discovered in 1832 by Dumas and Laurent. Q. 32. What, if anything, did Graebe and Liebermann invent in this connection? A. Having discovered that alizarine is a derivative of anthracene, they invented a process for producing it from anthracene; alizarine differs from anthracene in containing two atoms of oxygen in the place of two atoms of hydrogen, and two molecules of hydroxyl (OH) in place of two atoms of hydrogen thus—

"Anthracene is C_{14}, H_{10}, and

"Alizarine is $C_{14} H_6 \left\{ \begin{matrix} O_2 \\ (OH)_2 \end{matrix} \right.$; or, $C_{14} H_8 O_4$.

"Graebe and Liebermann employed well known processes for substituting O_2 H_2 and (OH), for H_2, and thus obtained alizarine from anthracene." Please say if you regard this as a fair statement of the discovery of Graebe and Liebermann?

A. I do not. In the first place, the expression, "it re-
638 veals its parent hydro-carbon," tends to convey the impression that anthracene was in some ordinary sense the parent of the alizarine of madder, or in other words, that the alizarine of madder was in some sense derived or produced from anthracene, a statement which would be utterly untrue.

Of the countless tons of alizarine which have been developed in madder root, not one atom was or could have been produced from anthracine.

Secondly.—The description in answer 32 is so worded as to de-

tract from the real originalty and difficulty of the process invented by Graebe and Liebermann. Dr. Chandler's own description of the same process, given in his answer to question 8, is a far more correct and worthy expression of the facts. It reads as follows:

"1. Graebe and Liebermann first discovered that a relation existed between alizarine and anthracine by obtaining anthracine from alizarine by heating it with zinc dust. They prepared alizarine from anthracine by first replacing H_2 by O_2, and producing anthraquinone $C_{14} H_8 O_2$. In this body they replaced H_2 by Br_2, by treating the anthraquinone with bromine, and producing bibrom-anthraquinone $C_{14} H_6 Br_2 O_2$. They then replaced the bromine by hydroxyl, by heating with potassic hydrate K O H, producing potassic alizarate $C_{14} H_6 (K O)_2 O_2$. By decomposing this with an acid, as hydrochloric, they substituted hydrogen for potassium, and produced alizarine $C_{14} H_6 (O H)_2 O_2$."

It is true that when we fully realize the immense practical importance of this discovery, the most meagre statement cannot fail to be impressive. It is as though we said A, B, were the first to convert a diamond by intense heat into plumbaco, (a thing which has been done,) and thereupon discovered a method of converting plumbago into diamond; but the ability and merit involved in such a discovery would be much more evident if we were to describe numerous ingenious steps of transformation by which the relatively worthless plumbago was step by step transformed into the gem; and if we added that the problem here solved, of producing diamonds artificially, was one which had engaged the attention of the ablest chemists for many years, the true merits of the discovery would be then fully presented. Yet this is a perfectly fair parallel to the discovery of Graebe and Liebermann.

Thirdly.—In all these answers Dr. Chandler omits to mention the fact that the substance produced by Graebe and Liebermann was not the alizarine of madder $C_{14} H_8 O_4$, but a much more complex mixture, which was also vastly more valuable as a commercial product. As a matter of pure science, the most interesting part of their invention and discovery was, perhaps, that to which Dr. Chandler has directed exclusive attention, but as regards its influence in the arts, their discovery and production of a new dye stuff capable of replacing madder extracts was of primary importance.

639 Lastly.—Dr. Chandler has stated in his answer 32 that "Graebe and Liebermann employed well-known processes for substituting O_2 for H_2, and $(O H)_2$ for H_2, and thus obtained alizarine from anthracine. Such a statement as this would certainly convey the idea that there was nothing of invention or discovery in those processes which Dr. Chandler himself credits to Graebe and Liebermann in the part of the answer to question 8, which we have already quoted, and that any well-informed chemist, knowing the composition of anthracene and alizarine, as given by Dr. Chandler, would know without experiment that these meth-

ods would produce the desired conversion. Such a statement would, however, be entirely at variance with the facts. It was known that with certain bodies a certain treatment would replace H with O, but it was by no means known, and could not be argued from analogy, that the same treatment would produce a like result with another body.

Graebe and Liebermann were, without question, the first to heat alizarine with zinc dust, and so produce anthracine; they were the first to combine bromine with anthrachinone so as to form the new body, bi-brom-anthrachinone; they were the first to combine chlorine with anthrachinone so as to produce bi-chloranthrachinone, and they were the first to heat either of these new compounds with caustic potash, so as to produce the new substance which is the subject matter of their patent. To say that these were well-known processes, because other bodies had been combined with bromine or with chlorine, or heated with caustic potash, producing entirely different products, would be like saying that the Bessemer process for the manufacture of steel was well known, because a blast of air, as a means of oxydizing an impurity, had been used for centuries in the extraction of silver from lead.

Q. 35. Please examine the quotations and references given in Prof. Chandler's testimony, defendants' record, answers 11 and 12, and state whether or not they prove the identity of the artificial alizarine of complainants' patent with alizarine from madder, and give your reasons for any opinion you may express?

A. It will avoid confusion if at the outset of my answer I make the following distinction: If we have in view the question of identity between the chemically pure alizarine of the formula $C_{14} H_8 O_4$, extracted from madder products, and a corresponding substance extracted from artificial alizarine, it is commonly conceded that they are identical, and wherever Dr. Chandler, or the authors whom he quotes, have had reference to this identity, their statements agree with the general belief; but wherever the identity implied is that between the compound body or mixture, artificial alizarine, made known in complainants' patent, and the chemically pure alizarine or any of the compounds known as madder extracts or preparations, it is evident from facts which I have already
640 stated, that the statement of such identity must be the result of ignorance or misapprehension, or the careless use of the word identity, where the fact of equal efficiency for a given purpose is what is intended to be stated. Thus, in the first authority quoted by Dr. Chandler, Wagner, in 1869, we read:

"The artificial preparation of alizarine from anthracence has been accomplished. The properties of the product obtained, as well as the colors produced on mordanted cotton, prove completely the identity of the artificial alizarine with that obtained from madder."

This statement was made in 1868, when no more was known about artificial alizarine of Graebe and Liebermann than the mere

fact of its discovery, and therefore the statement of Wagner can only be regarded as of the most general character, and really signified the similarity in practical effect which I have already mentioned, and indeed can have very little weight, if supposed to imply anything involving a knowledge of detail which has not yet been investigated.

This same author, however, in the continuation of the same work in 1872, says as follows, page 717:

"*Application of the artificial alizarine in printing.*

"In print works, as time advances, the artificial alizarine is more and more used, and latterly it has been especially employed for printing cloth in well-defined patterns. The ease of printing, the purity of the colors and of the designs, mark in the most striking manner the value of the new preparation." In this case the author evidently recognizes the new character and nature of the artificial alizarine, which he distinctly characterizes a "*new* preparation," although at this time the researches of Perkin and Auerbach had not yet been published.

Dr. Chandler's second quotation is from an article by W. H. Perkin, read before the Chemical Society of London, and published in their Journal for 1870, page 140. The portion quoted by Dr. Chandler is as follows:

"The coloring matter obtained either by Graebe and Liebermann's original process or from the sulpho-acid of anthraquinone, I have invariably called *alizarine*. The identity of this substance with the alizarine of madder has, however, been called in question. I have, therefore, made some experiments upon this subject, and carefully examined these two products side by side. For this purpose I have employed both purified, sublimed, and unsublimed artificial alizarine, and for comparison, purified sublimed alizarine prepared from madder extract. I find that both the natural and artificial bodies crystalize in needles, which are usually curved, especially when small.

"When dissolved in caustic alkali they both form violent solutions of the same tint.

641 "When applied to mordanted fabrics, they produce exactly the same colors, bearing the treatment with soap equally. They also possess the same tinctorial value.

"When dissolved in alchohol, they produce, with cupric acetate, a purple solution of precisely the same shade of color.

"When examined with a spectroscope, their potassic solutions produce the same absorption bands.

"Lastly, the ordinary precipitated artificial alizarine yields phthalic acid when decomposed with nitric acid.

"I know of no other well-defined reaction of alizarine, and therefore, judging from these, we are bound to consider artificial and natural alizarine as identical."

Here the author is, as we see, speaking of *purified* products from

the two sources, in fact, chemically pure alizarine obtained from madder and from the new substance; for in addition to the actual statement to that effect—in the words "for this purpose I have employed both purified, sublimed, and unsublimed artificial alizarine, for comparison, purified sublimed alizarine prepared from madder and extract"—he further states, in the latter part of the same article, not contained in the above extract of Prof. Chandler, but found at page 143, as follows:

"Artificial alizarine as supplied to the dyer and printer is not chemically pure, and usually produces with alumina mordants, color somewhat redder than madder. It has been stated that this is due to the presence of purpurine; this, however, is not the case, as none of this coloring matter can be detected even by Prof. Stokes' test; Dr. Schunck has also confirmed this.

"The shade of color produced with artificial alizarine may be modified to some extent by regulating the temperature of the dye-bath, the colors on the alumina mordants being nearer to those produced with madder, when a low temperature is employed. The redder shade produced with this coloring matter is however often preferred, especially for Turkey red dyeing. The quality of the coloring matter appears to be under the control of the manufacturer to a considerable extent, and it is possible that eventually artificial alizarine will be prepared in a nearly chemically pure state.

"When purifying artificial alizarine by converting it into an alumina lake, I found that upon digestion with carbonate of potash, this lake gave a red-colored solution containing a coloring matter dyeing mordants very similarly to alizarine, with this difference, that the reds were more scarlet, and the purples bluer or more slaty." From which it appears that he clearly recognized the existence of a new efficient dyeing principle in the artificial alizarine.

It is hardly necessary to say that his subsequent brilliant
642 discovery of anthrapurpurine was the most complete refutation of the error which would have been contained in the statement quoted by Dr. Chandler, had that implied the identity of pure alizarine or of any madder extract with the artificial aliazrine of Graebe and Liebermann.

III.—Dr. Chandler's next quotation is from the "Dictionaire de Chimie," by Wurtz, 1870, in an article on madder, by Schutzenberger, as follows: "Messrs. Graebe and Liebermann have in effect demonstrated that alizarine, heated with zinc dust, looses its oxygen and produces anthracene, and further, the anthracene is converted by oxydation into anthraquinone, which may, in turn, be converted into bi-bromanthraquinone; finally, by heating this product with potassic hydrate, they have realized the remarkable synthesis of alizarine."

This statement bears on its face so plain an impress of a mere generalization that no comment is needed. Even supposing that this author intended by "alizarine" the chemically pure substance, his statement would in no wise imply that many other effi-

fact of its discovery, and therefore the statement of Wagner can only be regarded as of the most general character, and really signified the similarity in practical effect which I have already mentioned, and indeed can have very little weight, if supposed to imply anything involving a knowledge of detail which has not yet been investigated.

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This statement bears on its face so plain an impress of a mere generalization that no comment is needed. Even supposing that this author intended by "alizarine" the chemically pure substance, his statement would in no wise imply that many other effi-

cient dyeing elements were not contained in the product at the same time.

IV. Dr. Chandler's next quotation is from Graebe, in the "Neues Handwörterbuch, der Chemie," Brunswick, 1871, vol. I, page 235, as follows:

"'Alizarine, lizareic acid, madder-red.

"'Prepared from madder first by Robiquet and Colin, 1826; artificially by Graebe and Liebermann, 1868, from anthracene; formula C_{14} H_8 O_4 derived from anthracene, and is to be considered as the di-oxy-anthraquinone C_{14} H_6 (O_2) $(O\,H)_2$.'

"He further says, on page 236, after describing the preparation of alizarine from anthracene, that 'it appears in commerce as a paste or powder, as that obtained from madder.'

"'Chemically pure alizarine is obtained by the sublimation of the pure madder extract, prepared by E. Kopp's method, or of artificial alizarine.'"

The author here tells us in so many words that it is the pure sublimed products extracted from madder and from artificial alizarine, of whose identity he speaks.

Moreover, in his later publications we find such statements as the following:

In reference to the actual composition of artificial alizarine in a part of the official report on the Vienna Exhibition of 1873, p. 26.

"As has already been stated in the introduction, there is always produced in the fusion of the anthrachinone-sulpho-acids with caustic soda, besides alizarine, a dyestuff, having the same composition as purpurine in greater or less quantities. As a consequence of this, it is also contained in varying quantities, in commercial ali-
643 zarine; in the smallest quantity, in the alizarine for violets, most abundantly in the alizarine for red. It cannot be called a bi-product, because for the production of certain red shades it has advantages even over alizarine."

V.—Dr. Chandler's next reference is to Bertholet, in his "Chimie Organique," Paris, 1872, page 246, as follows:

"Alizarine, the coloring principle extracted from madder, is related to anthracene, because it produces this hydro-carbon when its vapor is digested with zinc dust at a dull red heat, and it can be reproduced synthetically from anthracene."

This statement really involves nothing whatever in the present connection, for his test of relationship would equally apply to anthraquinone, which is not even a dyeing principle, and dozens of other compounds, all of which would produce anthracene if heated with zinc dust, and can be reproduced from it.

VI.—Dr. Chandler's next reference is from Dr. Adolph Pinner, in his "Repetitorium der Organischen Chemie," Berlin, 1872, page 256, as follows:

"Anthraquinone, when treated with bromine, yields bi-brom-anthraquinone C_{14} H_6 Br_2 O_2 and this exchanges its two atoms of bromine for hydroxyl, when it is heated with potassic hydrate, so

that a substance $C_{14}H_6(OH)_2O_2 = C_{14}H_8O_4$ is produced, di-oxyd-anthraquinone or alizarine.

"Alizarine $C_{14}H_8O_4$ is, like indigo blue, a vegetable dyestuff, which does not occur already formed in the plants, but is produced from a glucoside contained in the plants, by a kind of fermentation. In the madder root (rubia tinctorium) occurs a substance which has been called ruberythric acid, having the composition $C_{26}H_{28}O_{14}$ and splitting by fermentation, or on boiling with dilute acids, or alkalies, into a sugar and alizarine $C_{26}H_{28}O_{14}+2H_4O = 2C_6H_{12}O_6+C_{14}H_8O_4$."

This author simply states that alizarine is produced by the process of Graebe and Liebermann, but neither asserts nor denies that it is accompanied by other efficient dyeing principles. Indeed, at this date, Perkin's results being not yet published, this author could only presume on his ignorance, if he made any decided statement on this subject.

VII.—Dr. Chandler's next reference is to the first supplement of Watt's Dictionary of Chemistry, page 82, article alizarine, as follows:

"Wolf and Strecker assigned to this body the formula $C_{10}H_6O_3$, founded on certain relations which it was supposed to bear to naphthaline and phthalic acid. Schunck, on the other hand, represented it by the formula $C_{14}H_{10}O_4$ founded upon the analysis of alizarine itself, and its compound with bases; and finally Graebe and
644 Liebermann assign to it the formula $C_{14}H_8O_4$ based upon the conversion of alizarine into anthracene $C_{14}H_{10}$ by heating with zinc dust—$C_{14}H_8O_4+Zn_5+H_2O = C_{14}H_{16}+5ZnO$. The correctness of this formula has lately been very strikingly confirmed by the further discovery of Graebe and Liebermann, that alizarine may also be produced from anthracene."

This statement seems to imply only, like the foregoing, that pure alizarine is *a* (*i. e.*, one of the products) product of Graebe and Liebermann's process, and if it is considered to mean anything further in the direction of suggesting the identity of pure alizarine and the new product of Graebe and Liebermann, then it has been controverted by the same author in his second supplement, where he says "the pigment" (which he here calls "anthracene alizarene") containing much "anthrapurpurine," etc., etc.

VIII.—Dr. Chandler's next quotation is from Auerbach, in his work, "Das Anthracen und seine Derivate, 1873, page 98, as follows:

"The identity of artificial alizarine with natural alizarine was for a long time denied, but it has been established beyond doubt by the more accurate investigations of Schunck, Perkin, Bolley, E. Kopp and others."

In the case of this author, again, we may either consider that he speaks of the pure extracted dyeing element alizarine of the formula $C_{14}H_8O_4$ or that he has corrected his first erroneous impression in his later works, for it is he who has discovered isopurpu-

rine, and proved its efficiency as a dyeing element in artificial alizarine.

Of the authors to whom he refers, we may say the same, for Schunck has discovered anthraflavic acid, Perkin anthrapurpurine, in artificial alizarine, while Bolley and Kopp describe artificial alizarine as containing anthrapurpurine and isopurpurine in their "Traite des Matieres Colorant Artificielle, &c.," 1874.

IX.—Dr. Chandler's next reference is from "Wohler's Outlines of Organic Chemistry," Philadelphia, 1873, in which, according to Dr. Chandler's testimony, the author says in effect, "that alizarine is contained in old madder, and can be artificially prepared by heating derivatives of anthraquinone with caustic potassa, dissolving in water, and precipitating with hydrochloric acid. He then describes the properties of alizarine, without making any distinction between that from madder and that from anthracene."

In this case again, from this very brief treatment of the subject we should judge that the author was either speaking of the pure extracted product only, or that his general statement implied either intentional indefiniteness or a want of precise knowledge, since the results of Perkin and Auerbach had been published at that time.

645 X.—Dr. Chandler's next reference is to the "New Chemistry," by Prof. Cooke, New York, 1874, page 318, where it is stated "alizarine is the coloring principle of the madder root;" and that "now alizarine is manufactured on a large scale from the anthracene obtained from coal tar." * * * * "Here are pieces of cloth, one printed with madder and the other with artificial alizarine, and the most expert calico printer could not distinguish between them."

Here the word alizarine is evidently used in its general sense of a dyestuff, having the common characteristics of madder, and the statement only amounts to what is freely admitted, and, indeed, claimed by complainants, namely, that the results obtained by the use of artificial alizarine may be entirely similar to those obtained with madder, but this in no way implies identity, or, indeed, any close relation between the bodies. By chemical means, there is no difficulty whatever in distinguishing cloth dyed with madder from that dyed with artificial alizarine.

XI.—Dr. Chandler's next quotation is from Schorlemmer, who in his Chemistry of the Carbon Compounds, London, p. 448, says as follows, under the heading "Alizarine."

"This interesting and important compound exists in madder root, * * * * * * * and, therefore, ground madder which has been exposed to the air for some years contains free alizarine, which may be extracted with ether or petroleum spirit." He further says: "Alizarine is produced artificially." Dr. Chandler then adds, "describing processes I have already mentioned in my testimony. He then goes on to describe the properties of alizarine from both sources, without making any

distinction between that from madder and that from anthracene. He makes a statement which might at first be inferred to indicate a difference in describing the different methods of calico printing, after describing the use of madder in the dyebeck, as already described by me in my testimony; he remarks 'that artificial alizarine is chiefly used for topical printing.' He then describes the process, and closes the paragraph by saying:

"The colors thus produced are more brilliant than those obtained by madder."

"He does not state, what is a fact in this case, that the increased brilliancy is due to to the topical printing and the use of alizarine free from the various impurities of madder, and not to the use of artificial alizarine instead of that derived from madder."

The author here quoted and commented upon as above, in the first part of his remarks evidently refers to the pure, extracted material of the formula C_{14} H_8 O_4 and subsequently, when he alludes to the new dyestuff, draws attention to the greater use of the artificial alizarine in topical printing, and the superior
646 brilliancy of its colors. This last statement Dr. Chandler attempts to explain away, but if we go a few pages further than the passage which Dr. Chandler has quoted, we shall find on page 452 as follows:

"Anthrapurpurine has been found in artificial alizarine. * * * * * It has about the same affinity for mordants as alizarine, giving similar shades, but the reds are much purer, purples more blue, and the blacks more intense. When used to die Turkey red it produces a brilliant scarlet, which is of a remarkable permanence." From this full quotation of the author it appears that he recognized the presence of anthrapurpurine in artificial alizarine and its efficiency in producing specially brilliant colors, so that we thus see that Dr. Chandler's explanation is quite inconsistent with the facts as known and stated by the author, when fully quoted.

XII.—The next quotation of Dr. Chandler is from "A Practical Hand-Book of Dyeing and Calico Printing," by William Crookes, London, 1874, as follows:

"Identity of artificial and natural alizarine was for a time doubted, in consequence of experiments made with impure products; certain chemists found that tissues dyed with artificial alizarine lost a considerable amount of color on treatment with soda-lye. This result was probably due to the presence of tinctorial colors other than alizarine."

This quotation seems to me rather to show the difference than the identity of the two dye-stuffs under consideration, and the same author on succeeding pages refers to anthrapurpurine and its properties as a dye-stuff, see page 327, and in his appendix on page 682, says, as follows:

"*Artificial Isopurpurine.*

"This isomer of purpurine has been recently discoved by Auerbach in the product prepared by Gessert Bros., of Elberfeld, under the name of alizarine, with a yellow reflection of purpurine, because it produces—both in dyeing with an aluminous mordant, or as a steam color in printing—shades similar to those obtained with the natural purpurine from madder."

Its extractions and properties are then fully described. On page 683, we have again as follows:

"*Anthrapurpurine.*

"We have already given (page 327) a brief notice of the anthrapurpurine discovered by Mr. W. H. Perkin; we add the following particulars: Crude artificial alizarine is dissolved in a dilute solution of carbonate of soda, and the liquor is agitated with alumina recently precipitated."

Hereupon follows a full description of the lengthy process necessary to obtain this body in a pure state.

647 XIII.—Dr. Chandler's next reference is to a paper of Graebe and Liebermann, read before the Chemical Society of Berlin, on January 11th, 1869, in which they state as follows:

"We have now been so fortunate as to solve this second problem: we have prepared artificial alizarine from anthracene. The properties of the products obtained by us, as well as the colors which we have obtained with it on mordanted cotton, prove completely the identity of artificial alizarine with that obtained from madder root."

It is to be remembered that Messrs. Graebe and Liebermann are scientific chemists, devoting their lives to refined researches in matters of theoretical, rather than industrial, chemistry. It is, therefore, to the sublimed alizarine alone, which they supposed to be pure, that they directed the attention of a learned scientific body.

Their statement then simply means that purified sublimed alizarine obtained from their product was identical with purified sublimed alizarine obtained from madder; this, as we have already said, is generally admitted.

That such is their meaning appears beyond question if we read the remainder of the paragraph which Dr. Chandler has only partially quoted. Immediately following the last words quoted by him we read: "We submit to the inspection of the society samples of the sublimed artificial die-stuff, as well as patterns of calicoes dyed therewith."

Dr. Chandler's final quotation is also from a paper of Graebe and Liebermann, read at a meeting of the same society, on June 12th, 1869, in which they say as follows:

"Already in our first note we have referred to the fact that we have found no difference between natural and artificial alizarine;

that the very characteristic colors produced by both on cotton, mordanted with alumina and iron, are completely identical.

"We believe, therefore, that we have to do with one and the same chemical individual, and not with isomeric compounds, of which an extraordinarily large number is conceivable, and of which the chrysophanic acid, as we have proved, presents an example.

"In conclusion we will refer to the fact that our preparation of alizarine is the first example of the artificial formation of a dyestuff occuring in the vegetable kingdom."

The remarks which I have made in reference to the last quotation apply also to this. These learned chemists, addressing a society of learned chemists, naturally and appropriately spoke only of that which came into the domain of pure chemistry, that is, definite crystallizable chemically pure bodies, and disregarded all admixtures, which, however essential to the practical value of the matter in hand, were not yet so far studied as to be admitted within the domain of exact chemical science.

What they here say is generally admitted to be true in ref-
648 erence to the pure alizarine extracted from and forming one of the dyeing principles of madder, or of artificial alizarine.

In my remarks in reference to Dr. Chandler's fourth quotation in this same answer, I have shown conclusively what *is* the opinion of Graebe and Liebermann regarding the diversity and non-identity of the substances, madder extract and artificial alizarine.

At the conclusion of his series of quotations which we have above discussed, Dr. Chandler says as follows: "I will remark, that although some of the authorities which I have quoted do not say, in so many words, that natural and artificial alizarine are identical, they invariably say, in speaking of alizarine, that this body is obtained both from the madder root and from anthracene; and they then proceed and give one set of properties as characteristic of alizarine, no matter from what source it is obtained."

In the above I find in the first place a statement so liable to be misunderstood that a correction is necessary, namely: the statement that alizarine "is obtained both from the madder root and from anthracene." This certainly would imply that the process of obtaining bore some relation in the two cases, while in fact, in the case of madder root we have a simple process of extracting a body pre-existing and ready formed; while in the case of anthracene, we obtain it by a process of construction, building it up by a series of chemical combinations from a material which does not contain one particle of it either free or combined, and does not resemble it in the slightest degree in any particular. To confound or represent as identical these utterly distinct processes would of course be fatal to a correct understanding of the subject.

Indeed, no author has for an instant asserted that alizarine could be obtained from anthracene, in the sense in which it is obtained from madder extracts, and that which the authors quoted by Dr. Chandler have in certain cases expressed or implied, is that the

alizarine extracted from artificial alizarine and the alizarine extracted from madder root, were the same.

Q. 36. Having reference to Prof. Chandler's answer to question 13, in which he is asked "which of the authorities which you have named affirm positively that alizarine from madder root and artificial alizarine are identical." To which he answers in effect that Wagner, Perkin, Auerbach, Graebe, Crookes, and Graebe and Liebermann state this identity. Please state if you agree with the assertion here made or implied, and give your reasons?

A. In the first place I must draw attention to a peculiarity in the wording of the question asked him. Dr. Chandler is asked as to the statements of authors regarding the "alizarine from
649 madder root and artificial alizarine." This phrase, "alizarine from madder root," might well mean, and, indeed, Dr. Chandler has himself constantly employed it as meaning, any of the commercial madder extracts. (See his answer 4, fol. 38–43, inclusive.)

In his answer to *this question* 13, however, he has assumed it to mean chemically pure alizarine extracted from madder or its commercial extracts. This, his very first quotation shows, for it reads, "Chemically pure alizarine is obtained by the sublimation of the pure madder extract, prepared by E. Kopp's method, or of artificial alizarine."

The immense practical difference between chemically pure alizarine and madder extracts we have already shown, and if this ambiguity is not removed from the question, Dr. Chandler might seem to be making an assertion at variance with his own quotations and references.

Assuming, however, that the question is so interpreted as to refer to the chemically pure alizarine, and thus to be in accord with Dr. Chandler's answer, and assuming also that all the authors referred to by Dr. Chandler did at one time assert the identity of pure alizarine from madder with the artificial alizarine of Graebe and Liebermann, I would further remark that every one of them, as he acquired (directly by his own investigation or indirectly from study of the work of others) a fuller knowledge of the subject, corrected this erroneous opinion and published statements which were precisely contrary in their character, showing the important and radical differences between these substances.

This fully appears from the quotations from later writings of these authors, which I have given in my last previous answer.

Q. 37. In question 17, Prof. Chandler is asked, "Are there any obstacles, chemically or otherwise, that will prevent the obtaining of pure alizarine from the madder root or alizarine from this source free from the impurities you have named," to which he answers, "There are not." Do you agree with this opinion?

A. I do not. To obtain pure alizarine from madder would cost many times as much as the product so produced, if it were available as a dye-stuff, would be worth. But as a matter of fact this

expensive process would have greatly deteriorated the practical efficiency and commercial value of the product, so that it would be of very inferior value to an extract, in a chemical sense impure, containing purpurine and other useful elements. Such a proceeding would be similar to that of preparing from steel chemically pure iron, which, while enormously expensive, would yield a product relatively worthless for any industrial use or application; while this is of course not a *chemical* difficulty or obstacle, it appears to me to be a very serious practical and commercial one; and, indeed, it would appear from Dr. Chandler's descriptions of his methods of obtaining pure alizarine, and my examinations of the products obtained by following his directions, that he has in no case
650 succeeded in obtaining it strictly pure, so that it would appear that even to an eminent chemist this is a problem not without its difficulties.

Q. 38. In answer to question 18, Prof. Chandler states that "the impurities in artificial alizarine are anthracene, anthraquinone, oxanthraquinone, anthrapurpurine, a yellow compound which dyes cotton mordanted with alumina of an orange tint, other yellow bodies, the nature of which has not been determined, and the di-oxanthraquinone of chrysene, besides sulphates or chlorides of potassium or sodium."

Are these the only substances found in artificial alizarine, and which of them are to be regarded as impurities?

A. No mention is here made of isopurpurine, which, from Dr. Chandler's point of view, would, no doubt, be considered an impurity, and should, therefore, have found a place.

I do not, however, consider that in this material, which is essentially a dye stuff, any substance which adds to its practical efficiency as a dye stuff can be regarded as an impurity, and, therefore, I should say that anthrapurpurine, isopurpurine, the yellow compound which dyes cotton mordanted with alumina of an orange tint, and probably some of the other less known bodies, are in no sense impurities, but, on the contrary, are essential constituents of artificial alizarine as a dye stuff.

In evidence of which opinion I will submit four swatches, attached to the same sheet, marked Exhibit Morton 11, consisting of four swatches marked A B C and D respectively, of which A is dyed with purpurine, B with pure alizarine, C with anthrapurpurine, and D with isopurpurine. From inspection of these it will be seen that the colors obtained with anthrapurpurine and isopurpurine, which, according to Dr. Chandler's opinion, are impurities, are much more brilliant in the characteristic shades than those yielded by pure alizarine.

Q. 39. Is there any foundation for the statement assumed in question 19 and the answer thereto in Prof. Chandler's testimony, that the doubts hitherto "entertained concerning the identity of alizarine from madder and coal-tar alizarine or artificial alizarine, had disappeared?"

A. There is, in my estimation, none whatever, but, on the contrary, precisely the opposite has been most conclusively proved by all modern researches, and is universally admitted by all who are familiar with the later publications. Of course, I understand by artificial alizarine all the essential parts of the new substance first produced by Graebe and Liebermann, and not a single one of its elements separated from the rest.

The researches of Perkin, Auerbach, Koechlin, Schunck, and Rosenstiehl and others, which I have fully quoted, are really nothing more than the investigation of the important differences between alizarine from madder and artificial alizarine.

651 Q. 40. What were the substances which were referred to in Prof. Chandler's answer 20, to which Graebe and Liebermann ascribe the formula C^{14} H^{8} O^{4}?

A. They are the carefully purified and sublimed, or, in other words, thoroughly isolated dyeing elements, accurately described as chemically pure alizarine from madder, and chemically pure alizarine from artificial alizarine, which while, as I have said, dyeing elements or parts of dye stuffs, are neither of them dye stuffs or practically available in the arts.

Q. 41. Referring to Prof. Chandler's answer, in which he states the results of thirteen tests which he has applied, and which failed to show any difference between the alizarine from madder and that from anthracine, please state what is your opinion of the value of said tests and their relation to the question of identity involved?

A. In the first place, Dr. Chandler begins his answer with the following words:

"I purified very carefully some alizarine from madder and some of the defendant's alizarine from anthracene, and subjected both to a great variety of tests with the following results."

From this it appears that the bodies experimented upon by Dr. Chandler were not any of the preparations or extracts of madder used in the arts, or available as practical dye stuffs, nor the artificial alizarine manufactured and sold by defendants, but extracts from each of these which, to the best of his ability, he had *carefully purified*. In other words, the bodies compared by him were, as nearly as he could make them, chemically pure alizarine, extracted from madder and from artificial alizarine. If, therefore, Dr. Chandler had succeeded in extracting these materials in a perfectly pure state, it would be conceded that the tests applied by him, or any others now known, would yield like results with each substance.

Dr. Chandler does not here state how he "purified very carefully" his materials; but in answer to cross-question 100 he says:

"I prepared pure alizarine by a variety of processes," and then describes five methods of preparing pure alizarine from madder. I have repeated each of these methods with the greatest care, and find that when the products so obtained are heated with an alum solution, and are then examined with the spectroscope, as I have

described in my answer 12, or are examined for fluorescence, they distinctly show the bands of purpurine and its fluorescent color, while no such effects are obtained with the artificial alizarine under any condition. These tests, however, are not included in the thirteen given by Dr. Chandler.

Q. 42. In reference to question 22, in which Prof. Chandler is asked, "Can you distinguish between alizarine from madder and alizarine from anthracine or coal tar, providing they are both purified from extraneous substances?" to which he answers, "I cannot"—what would be your answer to the same question?

652 A. If by the two alizarines referred to I am to understand any of the commercial products so named, or any more or less thoroughly purified extracts thereof which were still available as dyestuffs, I answer that I should find no difficulty whatever in distinguishing between them. This ability to discriminate, in fact, goes so far that if I had a piece of cloth dyed or printed with one of these materials, and only one inch square, even though it has been in use as a garment, and worn and washed until a mere rag, I am able with entire certainty to determine whether it has been dyed or printed with madder or with artificial alizarine. If the question is supposed to refer to alizarine purified by any of the methods described by Dr. Chandler, I say that I should be able with a moderate quantity of the substance to determine its source; but I should do so in all cases by tests other than those described by Dr. Chandler.

Q. 43. In reference to questions and answers 23 and 24, of Prof. Chandler's deposition, which read as follows: "Q. 23. If you know, state whether or not alizarine was a commercial article for more than two years prior to the year 1869? A. It was. Q. 24. When was alizarine discovered; by whom, and when? A. By Robiquet and Colin, in 1824." Please state if the alizarine discovered by Robiquet and Colin was identical with the alizarine which was a commercial article?

A. It was not. Commercial alizarine, as I have already explained, is, and always has been, and, to be of practical value, must be a compound body, consisting of not only the pure alizarine first recognized by Robiquet and Colin, but also of purpurine, and probably one or more dyeing elements. The use of this word in these two questions is an excellent illustration of the latitude allowed in its application; for in question 24 it evidently indicates a chemically pure dyeing principle first separated by Robiquet and Colin, and in question 23 a commercial product in which this pure substance was only one of the efficient elements.

Q. 44. Having reference to Prof. Chandler's answer to question 38, said question and answer being as follows: "Q. 38. What can you say respecting the novelty of the artificial alizarine described in said letters patent? A. That it does not possess any novelty whatever." Please state if you agree with this opinion of Prof. Chandler, and if not, explain the cause of this difference of opinion?

A. I disagree entirely with Dr. Chandler in this matter, and believe that the artificial alizarine described in the said letters patent is an essentially new composition of matter; the cause of this difference of opinion between us is this: Dr. Chandler assumes (founding his opinion on a few partial quotations from publications made prior to the thorough investigation of the subject, and having, as he himself states, made no experiments with the product described in complainant's patent, which could have enlightened him
653 as to its true composition or action) that it consists of nothing but pure alizarine expressed by the chemical formula $C_{14} H_8 O_4$.

Dr. Chandler also assumes that the various madder extracts mentioned by him in his answer 4, (processes I to XIV inclusive,) which differ greatly among themselves, contained nothing efficient in the dye-bath but this same pure alizarine expressed by the formula $C_{14} H_8 O_4$.

I, myself, on the other hand, agreeing with the more recent writers on this subject, and with the investigators who have employed themselves for some years in studying the product of Graebe and Liebermann, described in this patent, and having myself made numerous experiments in producing the body in question, and separating it into its various constituents, and by making numerous dyeing tests with the original product, and with its various dyeing elements separately, I believe that this product (artificial alizarine) does not consist simply of pure alizarine indicated by the formula $C^{14} H^8 O^4$, but, on the contrary, is largely composed (viz: from 30 to 60 per cent. of the entire mass,) of iso- and anthrapurpurine, and that to the presence of these bodies, not to mention others, it owes its practical value as a commercial dyestuff. That, moreover, no question has been or can be raised as to the entire novelty of these substances.

My difference of opinion from Dr. Chandler comes, therefore, from the circumstance that I have taken into consideration researches and facts which he has not included in his consideration of the subject. In reference to the madder extracts, also, I hold with Napier, Naquet, Rosenstiehl and others whom I have quoted, in believing that all of these bodies, for their efficiency as practical dyestuffs, depend upon the presence in them of purpurine and other substances in addition to the pure alizarine which they contain, so that even if the product of Graebe and Liebermann had actually consisted of chemically pure alizarine only, it would not have been identical with these extracts previously in use.

Q. 45. Having reference to Prof. Chandler's answer to question 39, which reads as follows: "A. Nothing distinguishes the artificial alizarine described in the patent, from that extracted from madder more than two years prior to 1869, except certain impurities which may or may not be left in the product by the manufacturer, at his option;" please state if you agree with the above, and give your reasons for any opinion you may express?

A. As I have already fully shown in many previous answers, the artificial alizarine described in complainants' patent is a complex compound or mixture largely composed of certain efficient dyeing principles, such as anthrapurpurine, isopurpurine, etc., which not only were not "known and in use prior to 1869," but in all probability were not even in existence until first made by Graebe and Liebermann. The presence and properties of these substances, then, characterize and distinguish the alizarine described in
654 complainants' patent, from any substance before known. It is also without a trace of purpurine, which is one of the essential elements of all available madder alizarine, known and in public use prior to 1869.

Dr. Chandler makes the assertion contained in the answer quoted on the basis of three assumptions, which I have fully shown to be erroneous:

1st. That the artificial alizarine of the patent is for practical purposes nothing more than the pure alizarine represented by the formula $C^{14} H^8 O^4$.

2d. That the anthrapurpurine, isopurpurine, etc., are impurities, and not, as I have shown, essential and efficient constituents of this dyestuff.

3d. That the madder extracts in use prior to 1869 were pure alizarine represented by the formula $C^{14} H^8 O^4$.

All of these assumptions being, as I have shown in previous answers, in opposition to the facts, the conclusions founded on them naturally fall through.

As to these new bodies which Dr. Chandler calls "impurities," being left in the product or not by the manufacturer at his option; their removal would make the product cost many times as much as it would otherwise sell for, and would, besides, render it relatively worthless as a practical dyestuff.

Q. 46. Referring to Prof. Chandler's answer No. 40, which reads as follows: "A. The alizarine made by the process described in these letters patent does not possess any new chemical properties, nor are its physical characteristics in any respect different from those possessed by the alizarine previously prepared by other processes." Do you agree with the opinion thus expressed, or if not, please state your reasons?

A. As I have stated in my last answer, and have very fully explained and shown in many previous answers, the artificial alizarine of complainants' patent is a complex compound or mixture of several efficient dyeing agents, only one of which can in any sense be said to have been known or even to have existed prior to the discovery which is the subject matter of said patent.

All the distinguishing chemical and physical properties of these new substances are, therefore, "new chemical properties," or new "physical characteristics," pro tanto different from those possessed by the alizarines previously prepared by other processes, character-

izing "the alizarine made by the process described in these letters patent," and distinguishing it from all previously prepared.

Q. 47. Having reference to question 41, and Prof. Chandler's answer thereto, which reads as follows: "Q. 41. Does the so-called artificial alizarine described in said letters patent differ from the alizarine made from madder and its preparations or its de-
655 rivatives in any way whatever, so far as you have been able to determine? A. It does not, provided the impurities already alluded to be excluded." Do you agree with this statement, or if not, please state your reasons?

A. I do not agree with the opinion stated, because I consider that "the so-called artificial alizarine described in said letters patent" is the practically efficient dyestuff produced by the process described in said letters patent, which is a complex compound or mixture containing as essential constituents at least two entirely new compositions of matter which are no more impurities than is the pure alizarine there present, and which could be no better omitted from the product, regarded as a practical dyestuff, than could the alizarine itself. To remove these substances would, therefore, not be to have "the so-called alizarine described in said letters patent," but one of its elements.

The error which seems to me to characterize this answer is the same already so often noticed, namely, the confusion of the single dyeing element, chemically pure alizarine, which is not a practical dyestuff, with artificial alizarine described in complainants' patent, which is a practically efficient substitute for madder and its preparations.

Q. 48. Having reference to question 42, and Prof. Chandler's answer thereto, said question and answer reading as follows: "Q. 42. So far as you know, is the name 'alizarine' used by chemists and the manufacturers of dyestuffs in different senses, and do they refer to things quite different? A. The term alizarine is not used in different senses by chemists and manufacturers, and the term does not refer to things that are quite different; the term 'alizarine' is used to designate a definite chemical compound which appears in commerce, from different manufacturers, in different degrees of purity, as is the case with almost every other chemical product, as, for instance, caustic potassa, caustic soda, nitric acid, nitrate of potassa, &c." State whether you agree with the opinion here expressed by Prof. Chandler, and give the reasons on which your conclusions are founded.

A. I do not agree with Dr. Chandler's view, but believe that alizarine, as understood by the scientific chemist, and alizarine as understood by manufacturers, imply essentially different materials. For I find that the alizarine of the chemist is a definite, crystallizable, and pure compound, having the formula $C^{14}H^{8}O^{4}$ and certain distinguishing properties, chemical and physical, which serve to identify it. Among these properties, not the least important are that it produces an inferior red and pink, with alumina mor-

dants, and is, therefore, not a practically available dyestuff, and that neither purpurine, anthrapurpurine, isopurpurine, anthraflavic acid, or certain other bodies already mentioned, can be extracted from it. On the other hand, the alizarine of the manufacturer is a body not simple, pure, and crystallizable like the above,
656 but so complex in mixture of various essential constituents, that no formula can be made to express its actual composition, and distinguished by a series of characteristic properties, among which the most notable are, that it produces with alumina mordants rich crimsons and pinks, such as are the characteristic shades of madder dyes, and which is consequently a practically available dyestuff, and that purpurine and other matters on the one hand, and anthrapurpurine, isopurpurine and anthraflavic acid on the other hand, may be extracted from it according as it is an alizarine extracted from madder or an artificial alizarine constructed by chemical processes, as I have before described.

Of the use of this word to indicate these two essentially different kinds of materials, I have already illustrated by numerous quotations in my previous answers, and such illustrations might be multiplied indefinitely.

I do not consider that the difference between chemically pure alizarine and any form of commercial alizarine manufactured is simply, as Dr. Chandler suggests, a difference in the degree of purity, but believe that it is an essential difference, consisting in the presence or absence of certain essential ingredients, which, if present, render the mixture an available dyestuff, useful in the arts, and if absent, render it relatively worthless for any practical purpose.

If the bodies, caustic potash, etc., cited by Dr. Chandler as illustrations, contained in certain cases as impurities, substances which so essentially modified their properties that it was to the presence of these that they owed their value in manufacturing processes—for example, if chemically pure caustic potash would not produce a good soap, unless there were present in it a certain amount of sulphate of soda, the case would then be parallel to that now under consideration, and in that case the bodies containing such necessary ingredients would be essentially different from the caustic potash, etc., in a chemically pure state; and if the same word were used to designate both conditions of the bodies, it would be used in different senses and *would* "refer to things that are quite different."

Q. 49. Having reference to question 43, and Prof. Chandler's answer thereto, which read as follows: "Q. 43. Is that which chemists know as alizarine a rare preparation? A. It is not; although chemically pure alizarine, having no application in the arts, is rarely prepared, the same is true of caustic potassa, although, as the chemist occasionally requires chemically pure caustic potassa in analysis, while chemically pure alizarine is very rarely required by the chemist, the latter is not as often prepared as the former."

Please state if you agree with the conclusion there stated, and give your reasons for your opinions?

A. I do not agree with Dr. Chandler in his above statement. Alizarine, as known to chemists, is the substance whose formula is C_{14} H_8 O_4 and the difficulty of preparing it is extreme. I myself was occupied for several months in procuring two or three
657 grammes, whose value in time, labor and material would not be less than three hundred dollars.

In reference to the difficulty of obtaining pure alizarine, I may refer to the researches of Rosenstiehl, described by Naquet on page 563 of the Moniteur Scientifique for 1875, which I have quoted in my answer 30, page 60, in which he explains that none of the recommended methods yield a pure product, and that it is only recently that Mr. Rosenstiehl had succeeded in this by a method which he discovered by chance.

Also, Liebermann and Troschke remark in an article on the influence of ammonia on alizarine, in the Berichte der Deutschen Chemischen Gesellschaft, Berlin, 1875, page 377, "to obtain accurate results, it is, above all, necessary to begin with pure alizarine. The difficulty of procuring this is greater than is generally supposed. As commercial, natural as well as artificial alizarine is very impure. This circumstance cannot be stated with too great emphasis in connection with all such experiments as the above."

Dr. Chandler, also, himself, acknowledges that pure alizarine is even rarer than pure caustic potash, which sells in New York for six dollars a pound.

Q. 50. Having reference to question 44, and Prof. Chandler's answer thereto, which read as follows: "Q. 44. Manufacturers of dyestuffs have for a long time made and sold materials under the name of alizarine; do you understand this to be made up of a product from the madder plant, and the mixture of a great many different chemical products used in connection with mordants in dyeing and printing? A. I do not; the alizarine prepared by the manufacturers of dyestuffs is alizarine extracted from madder, and purified as far as the demands of the market require; the manufacturer did not find it to his interest to make his commercial preparation chemically pure, as the dyer and calico printers would not pay for the labor necessary to secure this result; the commercial alizarines were not admixtures purposely made by the manufacturers; they consisted of the alizarine of the madder, more or less completely freed from the other substances which are naturally associated with it in the madder root," and state if you agree with the opinion there expressed, and give your reasons?

A. The materials made by manufacturers of dyestuffs for a long time, and sold under the name of alizarine, and which are referred to in said answer, are in fact compounds or mixtures of several dyeing elements, all, however, derived from the madder plant, and used in combination with mordants in dyeing and calico printing. The reason why the substance known by chemists as alizarine is

not the only body left in these preparations, aside from all questions of expense, is that the manufacturer would not find it to his interest to prepare a practically useless article, nor "would
658 the dyer and calico printer pay for the labor necessary to produce this result."

While the commercial alizarines are not admixtures purposely made by the manufacturers, in the sense that separate things are brought together and mingled by them, they are admixtures of chemically pure alizarine with other available dyeing elements, which the manufacturers, if they understood their business, would be very careful not to remove from their product.

Q. 51. Having reference to questions 45 and 46 of Prof. Chandler's deposition, and his answers thereto, which read as follows: "Q. 45. Does the so-called artificial alizarine described in the patent disclose, either chemically or practically, characters which easily distinguish it from the alizarine from madder? A. It does not, when freed from the impurities which occur in the crude product. Q. Can you name a single point of difference between alizarine from madder and the so-called artificial alizarine made and described in the patent on which this suit is brought? A. I cannot; the alizarines from both sources are absolutely identical;" please state whether or not your answers 44, 45, 46 and 47 apply also to those questions and answers of his testimony just quoted.

A. I find nothing in the above quoted questions and answers 45 and 46, which is not included in the questions and answers of Dr. Chandler's testimony, 38, 39, 40 and 41, and upon these I have made very full comments already, in my answers, above enumerated.

Q. 52. In reference to question 47 and the answer of Prof. Chandler, which read as follows: "Q. 47. Will you say that there is no such thing as natural alizarine known to exist? A. I cannot, as natural alizarine exists in the madder root, as it appears in commerce, and in its various preparations, and it has been extracted as an article of commerce for many years." Please state what is your opinion in regard to the matter referred to in that question and answer?

A. If by "natural alizarine," Dr. Chandler intends to indicate the pure alizarine whose composition is expressed by the formula $C_{14} H_8 O_4$, and possessing certain properties, it is my opinion that such a body probably exists in madder root and in its various preparations. That it has been extracted in a condition of absolute purity by Rosenstiehl in 1875, and by myself in following his process, in this year, I think highly probable, but that it has been extracted as an article of commerce for many years, I am quite sure is not the case, and would not be asserted in this sense by Dr. Chandler, his statement as above being the result of a failure to discriminate between the substance alizarine, which we have reason to believe is a definite body, existing, as I have above stated, and commercial alizarines or madder extracts, which contain it in addition to other various dyeing elements.

659 If, on the other hand, he intends by "natural alizarine" to indicate such mixtures of alizarine with other dyeing elements as exist in the ordinary madder extracts, then I should say that that we could not speak of such a thing as a definite body, known to exist in the same sense in which a chemical definite compound which has been isolated and analyzed, is known to exist, but that in a general sense such a mixture existed in madder root, and that several such mixtures had been extracted as articles of commerce for many years.

Q. 53. Having reference to question and answer 50 of Prof. Chandler's deposition, which are as follows:

"Is it true that no formula will represent alizarine from madder and alizarine from coal tar? A. It is not; I have already given the formula for those two substances, and they are both represented by the same formula." Please state your opinion thereon.

A. I should in the first place remark that the question here proposed is so worded as to admit of two meanings. In the first place, by alizarine from coal tar, we may understand the artificial alizarine of complainants' patent; but this does not exist in coal tar. Coal tar contains about one per cent. of anthracene, and anthracene is the foundation upon which is built up the complex structure, artificial alizarine. Artificial alizarine may then be called alizarine from coal tar; this is, however, a compound of various dyeing elements in varying proportion and incapable of representation by any chemical formula.

Again, alizarine from madder may be understood in a commercial sense to mean one or other of the various madder extracts used in dyeing, which, however, are also complex dyeing materials, consisting of various dyeing elements in varying proportions, and hence incapable of being represented by a formula.

On the other hand, alizarine from coal tar may be understood to mean the substance chemically pure alizarine extracted from the artificial alizarine of complainants' patent, and alizarine from madder may mean the chemically pure alizarine extracted from commercial madder extracts. In this last sense the chemical formula C_{14} H_8 O_4 would represent them both.

If the alizarines referred to in the question, therefore, are the chemically pure alizarines, extracted as above from both sources, then Dr. Chandler's answer is correct. If they are the artificial alizarine of complainants' patent and commercial madder extracts, the answer would be absurd on its face, since the formula of chemically pure alizarine C_{14} H_8 O_4 cannot represent mixtures of this substance with other substances.

Q. 54. Having reference to questions and answers 51, 52, 53 and 54 inclusive, of Prof. Chandler's deposition, which read as follows:

"Q. 51. If you have examined the two kinds of alizarine, that is,
660 alizarine from madder and the so-called artificial alizarine, under a high magnifying power of the microscope, state if this examination showed any existing difference between the

two? A. I have examined them under the microscope, and could not detect any difference between the two. Q. 52. If you have tested the madder alizarine and the so-called artificial alizarine by bi-sulphide of carbon or other similar solvent, and evaporated the extract, state if you obtained crystals from both the madder alizarine and the so-called artificial alizarine? A. I have examined them both in this way, and they both yield crystals. Q. 53. State if the crystals in this way yielded had the same crystalline structure and form and color? A. They had all of these, and could not be distinguished from each other. Q. 54. If you have sublimed the madder alizarine and the so-called artificial alizarine, and in that way produced crystals, state if such crystals were the same in every way? A. They were." Please state your opinion respecting the matters therein contained?

A. If the two kinds of alizarine here considered are the chemically pure alizarine extracted from the artificial alizarine of complainant's patent and from commercial madder extracts, the answers are correct.

If they apply to the artificial alizarine of complainant's patent and to commercial alizarine or madder extracts, they are not in accordance with the facts.

Q. 55. Having reference to Prof. Chandler's question and answer 55, which read as follows: "Q. 55. If you have decomposed the madder alizarine and the so-called artificial alizarine, and have purified them, state if the madder alizarine, after such purification, gave indications of its vegetable origin? A. It did not." Please state your opinion on the same?

A. The question here unequivocally refers to the artificial alizarine of complainant's patent, and to commercial alizarine or madder extracts, in the first place, and to the chemically pure extracts from both in the second place, and the answer having reference clearly to the chemically pure extracts from madder extracts only, is entirely correct, so far as Dr. Chandler is concerned; but as I have elsewhere shown it is exceedingly probable that none of the preparations prepared by Dr. Chandler were free from purpurine, and by applying the optical tests, which I have elsewhere described, their vegetable origin could in this way have been readily recognized.

Q. 56. Having reference to Prof. Chandler's questions and answer 56, which read as follows: "Q. 56. If you have made still other tests concerning the madder alizarine and the so-called artificial alizarine, state if such other tests revealed any differences in the two substances so tested? A. I have made numerous other tests, and in no case have I been able to detect any difference between the two substances." Please state your opinion on the subject therein mentioned.

661 A. The question here would seem to be almost explicit, as referring to the madder extracts and artificial alizarine each as a whole, and yet I cannot believe that Dr. Chandler so understood it, for in that case his answer would be entirely at varience

with the facts of the case. For, as I have already shown, nothing is easier than by the simplest tests to distinguish between the two substances, or even between articles dyed with them. If, however, he intended to refer to extracts obtained from these sources, as nearly chemically pure as he was able to obtain them by the processes which he has described, Dr. Chandler may have readily failed to distinguish.

Q. 57. Having reference to question and answer 57 of Prof. Chandler's deposition, which read as follows: "Q. 57. Could the impurities of all kinds be removed from the madder alizarine without destroying it? A. They could." Please state your opinion thereon?

A. If by impurities in madder alizarine we understand everything which madder or its extracts contains, except chemically pure alizarine, $C_{14}H_8O_4$, I would say that they cannot all be removed without great loss and partial destruction of the chemically pure alizarine itself, and a total destruction of a large part of the efficient dyeing elements which are present in the root and its commercial extracts, and the great deterioration of what is left, as a practical dyestuff. A portion of chemically pure alizarine could however be obtained from madder or its extracts by appropriate treatment.

Q. 58. Having reference to Prof. Chandler's question and answer 60, which read as follows: "Q. 60. Is it not a matter of fact that if this amorphous waxy matter and all other impurities were removed from the madder alizarine that it would then be improved as a dyeing principle? A. It is." Please state whether you agree with Prof. Chandler in the opinion here expressed?

A. Bearing in mind that Dr. Chandler designates as impurities in madder all substances but chemically pure alizarine $C_{14}H_8O_4$, I am obliged to say that having obtained and experimented with this body, chemically pure alizarine, I am convinced that it would be relatively worthless as a dyestuff compared with the ordinary madder extracts; its most valuable tints, the red and pink colors, being immensely deteriorated.

Q. 59. Having reference to question and answer 64 in Prof. Chandler's testimony, which read as follows: Q. 64. "Do you know of a well defined crystalline compound, obtained by the chemical treatment of the madder plant, and known as alizarine, that could not be used for dyeing? A. I do not." And state if you agree with Prof. Chandler as to the matter there referred to?

A. Chemically pure alizarine when sublimed is a well defined crystalline compound, obtained by the chemical treatment of the madder plant, and known to chemists as alizarine. It could not be
662 employed practically in the arts as a dyestuff, both on account of its inferior tinctorial effect, and also to the great expense of its preparation. When, therefore, we are speaking of the practical art of dyeing, I think it would not be false to say that this body could not be used for dyeing, although, of course, for laboratory experiments it will produce colors on mordanted cloth,

and therefore in a certain limited sense, excluding all practical applications, it might also be said that it could be used for dyeing.

Q. 60. Having reference to question and answer 65 of Prof. Chandler's testimony, which read as follows: "Q. 65. Do you know of a compound or preparation made from madder, which is not a definite chemical compound, but which is a mixture of many things made by French manufacturers, and by them called alizarine, and employed in dyeing? A. I know of nothing to which that description would properly apply; French manufacturers prepare alizarine of different degrees of purity, and supply the same for the use of dyers and calico printers." Please state your opinion on the subject therein mentioned.

A. I think that the green and yellow alizarine of Kopp would fulfill all the conditions named in the question. Each of them is a compound or preparation made from madder, not a definite chemical compound, but a mixture of alizarine, purpurine, pseudopurpurine, etc. They are made by Messrs. Schaaff & Lauth, at Strasbourg, in Alsace, which at that time constituted a portion of the French empire, and they were therefore made by French manufacturers, and were called by them alizarine. They were also employed for dyeing until superseded by the artificial alizarine of Graebe and Liebermann. Bearing in mind that Dr. Chandler calls impurities bodies which I and other chemists have shown to be essential elements of a practical madder dyestuff, it will be seen that the latter part of his answer entirely supports my statement as above given.

Q. 61. Having reference to question and answer 66, in Prof. Chandler's testimony, which read as follows: "Q. 66. What difference, if any, exists between chemical alizarine and manufactured alizarine? A. There is no difference between them. There is only one substance to which the name alizarine belongs; this may be prepared from madder or from anthracene. It possesses definite and well-defined physical and chemical properties, by which it may be readily recognized and distinguished from all other substances. It is seen among manufacturers and in the chemists' laboratories in various degrees of purity; while the impurities may differ according to the mode of preparation, the alizarine is always the same." Please give your opinion upon the subject therein contained.

A. I find here two new terms introduced in the question—"chemical alizarine" and "manufactured alizarine"—which are nowhere defined in this record.

663 If these terms are intended to refer to alizarine chemically pure, extracted from or existing in the artificial alizarine of complainants' patent and in commercial madder alizarines, then the use of the two names can only imply some such difference as may exist between two almost identical isomers. Such a difference, I think, may very well exist, though I have been unwilling to hazard so speculative an opinion on my own part. The fact, however, that the purpurine in madder finds only an isomer in the artificial alizar-

ine certainly sustains the view. In this sense Dr. Chandler's answer would be quite correct.

If, however, the question refers to the compound dyestuffs, artificial alizarine, and commercial madder alizarines, in their entirety, then Dr. Chandler's answer is self-contradictory, as he first says there is no difference between them, and then admits that, while one of their constituents is always the same, all the others (which he assumes without having examined them—see his answers to cross questions, 156, 184, 185, 208, 209 and 233—to be impurities,) "may differ according to the modes of preparation."

Q. 62. Please refer in Prof. Chandler's deposition, to question and answer 70, which are as follows: "Q. 70. Do you find stated in Napier's Chemistry, before referred to, the substance of what is stated by the witness Hedrick in answer to cross question 72? A. I do not; such a statement is not contained in Napier's work," and also refer to Prof. Hedrick's answer 72, and state what, if anything, Napier says on the subject inquired about.

A. In order that the connection between Prof. Hedrick's statements and those of Napier may appear as clearly as possible, I will place them side by side on the page, using the Glasgow edition of Napier, to which Dr. Chandler refers:

Prof. Hedrick's answer 72: "He," (Napier) "states that the madder plant had been very carefully examined by chemists; they found during their researches that they could obtain two well-defined chemical compounds, but that these were not all that it contained; that these were zanthin and alizarine."

Napier's Manual of the Art of Dyeing, Glasgow, 1853, page 357: "Madder has been the subject of a great many chemical investigations, the study of which is highly useful to those who use this dye drug in their operations. The first investigation into the chemical properties of madder led to the discovery of two distinct coloring matters —one yellow, which is very soluble in cold water, and named zanthin; the other red, moderately soluble in hot water, is called alizarine."

664 "It was hoped that these would be the valuable parts of the plant or the valuable products derived from it, for it has always been a disputed point whether even these exist in the natural plant, but when tested by practical application they were found to be of no value as dyestuffs."

Page 358—"From the above reaction of alizarine with other substances it was supposed that it constituted the true coloring of madder, and means were soon adopted to separate this coloring matter from the vegetable, and use it pure; but it was afterwards found that a fixed dye could not be obtained by pure alizarine, and therefore it did not constitute all

that was required in giving the dye."

On page 360—"Indeed, practically, it is only necessary to consider madder as containing no more than two coloring matters as was formerly supposed, viz., the dun or yellow, which constitutes the impurity of the madder and which the dyer endeavors to get rid of, and the red-coloring matter. The former, or yellow, does not combine with the cloth alone, but it has a strong affinity for the other coloring matters, and combines with them when they are upon the cloth, and has to be separated from them by after processes."

It appears to me from the above that all the important points in Prof. Hedrick's statement are fully sustained by the passages I have quoted from Napier. It is true that Prof. Hedrick uses the term "madder plant" where he evidently means not the entire plant, but the root, and that he is mistaken in supposing that the discussion regarding the existence of zanthin and alizarine in the madder plant is mentioned by Napier in the early editions, but such a discussion undoubtedly did exist, as is stated in the edition of 1875, on page 299, in the following words: "And it is considered that alizarine does not exist ready formed in the growing root, but is the result of the decomposition of the Rubian;" but in the important statements that madder contains alizarine and a yellow principle, neither of which alone are practically valuable as dye-stuffs, I think Prof. Hedrick expresses correctly the passages I have quoted from Napier.

665 Q. 63. Having reference to question and answer 71 of Prof. Chandler's testimony, which reads as follows: "Q. 71. Have you consulted the London Journal of Arts for the past five years; the London Chemical News, and the Journal of the London Chemical Society for the same period; and if yea, do you find it stated in such journals that new physical characteristics are found in the alizarine made under the plaintiff's patent in suit? A. I have examined all these works and read everything they contain, since the beginning of 1868, in any way relating to alizarine, and I find numerous statements with regard to the identity of alizarine from madder and that from anthracene, the substance of which I have already given in my testimony. As I have already stated, when experiments were made upon impure alizarine from these two sources several differences in the physical and chemical characters were noticed, and a few chemists claimed, in consequence, that the two alizarines were

not identical; when these experiments were repeated with pure alizarine from both sources no physical or chemical differences could be detected between them, and consequently chemists now regard them as absolutely identical in every respect." Please state your opinion in regard to the matter therein referred to.

A. The answer of Dr. Chandler is only intelligible on the assumption that by "the alizarine made under complainants' patent in suit" he means the chemically pure extract, which he may have obtained, or endeavored to obtain, from that substance and from madder preparations. Assuming that by the alizarine made under complainants' patent in suit is meant the product of the process therein described, and called artificial alizarine, this answer would be irrelevant to the question, and at variance with the numerous statements which I have quoted in my answers 17 and 18.

Q. 64. Having reference to question and answer 72 of Prof. Chandler's testimony, which read as follows: "Q. 72. What is the difference, if any, existing between iron known to theoretical chemists and iron known to arts? A. There is no difference; iron is known both to chemists and to the arts as a distinct element, which, for practical purposes, is employed in different degrees of purity, as the impurities modify the properties of iron, different preparations have different applications, giving rise to different commercial qualities of iron, such as wrought iron and cast iron. The wrought iron is almost chemically pure, the steel contains from one to three per cent. of carbon, the cast iron contains about five per cent of carbon and silicon, with generally a little sulphur and phosphorus." Please give your opinion in regard to the matter therein referred to.

A. Iron, as known to chemists, is one of the elements possessed of certain distinguishing properties, and is a substance which, in its pure condition, or in other words, as a chemical element, would be relatively useless in the arts.

666 Iron in the arts exists as a series of compounds with carbon and other substances, which owe their distinctive and useful properties to the presence of such other substances which, viewed from the standpoint of pure chemistry, would be regarded as impurities. Steel, for example, owes its peculiar and valuable properties to the presence of a certain amount of carbon.

Q. 65. Having reference to question and answer 73 of Prof. Chandler's testimony, which read as follows: "Q. 73. Is it a fact that no such thing as madder alizarine is found in commerce, or that purified madder alizarine is not described in the books, or that if such material did exist it would not serve any purpose in the art of dyeing. A. None of these statements are true; madder alizarine is found in commerce; purified madder alizarine is described in the books, and as such it would be useful in the arts for dyeing." Please give your opinion in regard to the matter therein referred to?

A. I find here, as in so many other cases, an instance of the ambiguity which seems to have been cultivated with great success in this part of the testimony, by the use of the same terms to express

the artificial alizarine of complainants' patent and madder extracts at one time, and the chemically pure alizarine extracted from these sources at another.

If the expressions madder alizarine and purified alizarine refer to the commercial extracts, Dr. Chandler's answer is correct. If the chemically pure extract is indicated, then, 1st, it would be absurdly untrue to say that it was found in commerce; 2d, the description of it found in books up to the time of Rosenstiehl's process, quoted by me in answer 30, page 60, were founded on processes which could not produce it, and were of necessity, therefore, inaccurate; and 3d, as shown in numerous quotations, see my answer 30, pages 58 and 59, and by my own experiments and exhibits, it would be practically useless in the art of dyeing.

Q. 66. Having reference to question 74, and Dr. Chandler's answer thereto, which read as follows: "Q. You have stated that you made a spectroscopic analysis of madder alizarine and also of alizarine made by defendants, both of which were purified; state if this analysis produced the same absorption bands? A. It did; no difference could be detected between the alizarines by the spectroscope." Please state if you have made spectroscopic examinations of these substances, and if your results agree with those of Dr. Chandler here stated?

A. I have made such examinations, with results differing from those of Dr. Chandler, for the following reason: The solution which I employed was the solution in alum water, which, as is well known, furnishes the most certain test for the presence of purpurine; and by this means I never failed to detect the presence of purpurine in any of the madder alizarines prepared by the processes described
667 by Dr. Chandler, while none such appeared in any artificial alizarine. It was therefore easy in this way for me to detect the difference between these alizarines. Dr. Chandler, however, from his own description, in answer to question 21, does not appear to have examined his alum solution with the spectroscope, and therefore naturally failed to observe this difference. Having, therefore, failed to apply the spectroscope to the solution which was recommended as the best for the purpose, his conclusion that "no difference could be detected between the alizarines by the spectroscope" was at least hasty.

Q. 67. Having reference to what Prof. Chandler says in his testimony in this case about the swatches prepared and exhibited by him, state your opinion with regard to the identity of the same?

A. I have already stated, having repeated all the processes described by Dr. Chandler as having been used in the preparation of the pure extracts, and having found that none of them yielded pure alizarine, I am of opinion that to the eye of one experienced in examining dyeing tests or swatches the specimens introduced as exhibits by Dr. Chandler would not be likely to appear as identical.

Q. 68. Having reference to cross-question and Prof. Chandler's answer 189, which read as follows: "x-q. 189. What effect has the

discovery of Graebe and Liebermann had upon the madder culture and trade? A. It has diminished the madder culture by lowering the price of madder; their discovery indicated the possibility of preparing alizarine from anthracene, a possibility which has been realized by the invention of various processes, some of which are now in extensive use, for preparing the alizarine from this substance." Please give your opinion in regard to the statements of his answer?

A. Dr. Chandler's answer should be considered as consisting of two distinct portions, which we must regard separately, since they are inconsistent with each other, and therefore cannot be taken together. In the first place, he says that the discovery of Graebe and Liebermann has diminished the madder culture by lowering the price of madder. Now, it is perfectly evident that the market price of a commodity, of which $12,000,000 to $16,000,000 worth, on the avarage, was produced every year, and still more that the cultivation of a plant occupying 250,000 to 300,000 acres of land, would not be affected by a theoretical discovery in reference to it, unaccompanied by a practically successful process having reference to its production. As a matter of fact, moreover, Graebe and Liebermann did not in this connection make a purely theoretical discovery or invention, but proceeded at once, in May, 1869, in the factory of complainants, at Ludwigshafen on the Rhine, to the manufacture of their product on a commercial scale, and put upon the market within a year of the date of their invention, and it was this introduction of the new body into the market which lowered the price of madder and diminished its cultivation.

Bearing this in mind, we therefore see that the first part of
668 Dr. Chandler's answer, in which he says, referring to the discovery of Graebe and Liebermann, "it has diminished the madder culture by lowering the price of madder," is perfectly correct.

Turning, now, to the second part of Dr. Chandler's answer, I find him there state, in effect, that the discovery of Graebe and Liebermann only indicated the possibility of preparing the dyestuff alizarine from anthracene, and that this possibility was realized by subsequent inventions now in extensive use.

If this were a correct statement of the case it would be evidently inconsistent with the first portion of Dr. Chandler's answer, as above shown, since no such indication of possibility could have produced the effect stated. As a fact, however, the artificial alizarine manufactured at the present day is made substantially by the process invented by Graebe and Liebermann, and described by them in their patent, and practiced by them in 1869, no modifications having been introduced except such as amount to the mere substitution of one equivalent material for another.

Q. 69. Please present such exhibits as you have referred to in previous portions of your testimony, or any others which you have prepared for this purpose, giving a full description of them, with such

account of the methods of their preparation and character as may be necessary to fully explain them.

A. I present the accompanying specimens of anthrapurpurine in crystals by sublimation, marked Exhibit Morton No. 12, and of isopurpurine in like condition, marked Exhibit Morton No. 13, and would simply draw attention in this place to their entire difference in character from the sublimed purpurine or alizarine which I before presented, Exhibits Morton No. 7 and 8, although all were prepared under identical conditions. Their characteristics as practical dyeing elements will be illustrated in the swatches or specimens of dyed cloth which I will now present.

Swatches illustrating the effects of various materials when used in dyeing.

Exhibit Morton No. 9, showing comparative effects of purpurine, chemically pure alizarine, madder extract, and artificial alizarine.

This consists of four strips of cloth dyed in vertical stripes, with the materials named opposite to each strip on the card to which they are all attached, and shows the following characteristics: The first strip, dyed with purpurine, shows the characteristic scarlet color of that substance with strong alumina mordant, and the yellowish pink which it gives with the lighter alumina mordant; also the inferior violet and black which it develops with the iron mordants; its chocolate, also, with the mixed mordants, is peculiar and characteristic.

669 The second strip, dyed with chemically pure alizarine, shows the dull crimson and blueish or "dirty" pink which are the result of using this matter in a pure or unmixed state. The blueish purple and brownish black, with iron mordants, are also shown, and likewise the color which it imparts to the unmordanted parts of the cloth, and which is not removed by a thorough soaping.

The third strip, dyed with madder extract, shows the vivid red and the bright pink, which are the characteristic shades of madder and its commercial extracts, and which evidently result from the appropriate combination of the two characteristic colors shown in strips first and second, or purpurine and chemically pure alizarine. The violet is here inferior to that of the chemically pure alizarine, but the superiority of the red and pink, which are the types of madder colors, is too manifest to need comment.

The fourth strip, dyed with artificial alizarine, shows the same peculiarities of fine and clear reds and pinks, while at the same time, on account the presence of anthrapurpurine, its violet and black are are strong.

The method in which these specimens were made is as follows:

A large water-bath was prepared, capable of holding four beakers or cylindrical vessels of thin glass. Into each of these was put 250 grammes of distilled water, .012 grammes of lime as acetate in solution.

The dyeing substances were then added to the several beakers in the following quantities:

Purpurine, .052 grammes; pure alizarene, .048 grammes; madder extract, .092 grammes; artificial alizarine, .048 grammes. The quantities of purpurine and pure alizarine represent the relation of their combining weights. Madder extract containing a large amount of non-active material, a larger weight was found necessary to secure an equal amount of its effective ingredients. The artificial alizarine containing little beside effective matter in the shape mainly of alizarine, anthrapurpurine, and isopurpurine, I used no more of it than of the pure alizarine.

This set of swatches seems to me to show conclusively that, 1st, Artificial alizarine is an efficient substitute for madder extract; 2d. That chemically pure alizarine is not an efficient substitute for madder extract; 3d. That madder extract owes its superiority over chemically pure alizarine to the presence of purpurine.

To find if these characteristics would be greater or less with a less amount of dyeing material, I prepared the set of swatches marked Morton Exhibit No. 10, in which everything else remained the same, but the dyeing materials and lime were reduced to half. Exactly the same remarks which I have made about Exhibit No. 9 will, however, apply to this, so that it is evident these distinctions do not depend upon the quantities used, but are essential to the nature of the substances.

670 *Swatches exhibiting the comparative tinctorial effects of purpurine, chemically pure alizarine, anthrapurpurine and isopurpurine.*

Exhibit Morton No. 11 consists of four strips of cloth from the same piece of cotton, prepared with mordants for the purpose of such dyeing tests, which I have used in the preparation of all the swatch exhibits which I introduce in this ca e. The quantities of dyeing materials employed are the same in each case except the chemically pure alizarine, which, having a lower chemical equivalent, calls for a corresponding reduction in the weight used to secure a strictly accurate comparison, although, as may be seen from my Exhibits No. 9 and 10, no change in any way affecting my conclusions is produced by a large variation in the amounts employed.

The *first two strips* showing purpurine and chemically pure alizarine need no mention here, as they correspond in all respects with the first two strips of Exhibit Morton No. 9, which contain the same substances in the same amounts.

The third strip is dyed with anthrapurpurine, whose red surpasses even that of purpurine in its scarlet character, while its pink is purer, and its violet has become almost pure blue. Its color on the chocolate mordant is also easily distinguished from that of the purpurine, while in comparison with the pure alizarine there is not a single color at all alike between them. The strength of its violet is especially worthy of note, for this explains why, as we see in Exhibit Morton No. 9, the artificial alizarine, while giving a pure scarlet red like purpurine, also gives a rich violet like pure alizarine, and not a poor

violet like madder extract. This is because the anthrapurpurine not only takes the part which purpurine plays in madder for the reds, but has also this capacity for producing a strong bluish violet which purpurine lacks; anthrapurpurine also differs from purpurine in being a much faster color.

The fourth strip is dyed with isopurpurine, and the difference between its colors and those produced by purpurine, though less marked, is very manifest. The red and pink are more crimson and bluish, respectively; the violet is also bluer, and the black stronger. It differs, moreover, from the chemically pure alizarine in every color and in the most marked degree.

Bearing in mind that all of these materials except the pure alizarine are, according to Dr. Chandler's opinion, speaking no doubt as a chemist, "only impurities," one can see that there must be a difference in the way of regarding these materials between the chemist and the dyer, for the latter would certainly *not* regard as impurities in his dye-bath substances which, as we here see, yield by far the most brilliant colors which the entire dyestuffs contain, and which are absolutely necessary for the production, in dyeing and printing,
of turkey-red, madder reds and pinks, which, for their bril-
671 liancy and fastness, are considered the types of good colors;
but of course, to a chemist desirous of experimenting on pure alizarine, these substances are impurities, as silver would be in a mixture from which he was extracting pure lead, and *vice versa*.

(Counsel for complainant offers in evidence the swatches and the specimens of anthrapurpurine and isopurpurine, produced by the witness and referred to in his last answer, and the same are marked respectively Exhibits Morton Nos. 9, 10, 11, 12 and 13. R. E. S., exam'r.)

HENRY MORTON.

Subscribed and sworn to before me this 9th day of October, 1876.

R. E. STILWELL,
U. S. Com'r.

672 NEW YORK, *Oct.* 14, 1876.

Cross-examination of Prof. MORTON:

Present: J. Van Santvoord, counsel for complainants, and G. M. Plympton, counsel for defendants.

x-q. 70. In your answer to the 24th question you state that the influence of monoxanthrachinone and anthraflavic acid and Perkin's orange matter and other substances have not been settled, "though there can be no doubt that such an influence exists and is practically important." What do you mean by the statement that their influence has not yet been settled?

A. I mean that as far as my knowledge goes no experiments have been made showing precisely what influence each of these substances

exerted when used in the dye-beck in connection with the other materials, constituting together with them artificial alizarine.

x-q. 71. Have you experimented with monoxanthrachinone, anthraflavic acid and Perkin's orange matter and other substances, to determine if possible their influence in the dye-bath?

A. Not in such a way as to determine the specific influence of each, yet in such a manner as to indicate that they had in the aggregate an appreciable effect.

x-q. 72. What do you mean in your answer to the 24th question when you say in substance that the influence of anthrapurpurine and isopurpurine in the dye-bath have not yet been settled?

A. It was not my intention in the answer referred to, to state that the influence of anthrapurpurine and isopurpurine had not yet been settled, nor do I think that the phrasing of said answer fairly supports that construction, but that the reference is to "monoxanthrachinone, anthraflavic acid, Perkin's orange matter and other substances," only.

x-q. 73. You say in your answer to the 25th direct question, in defining alizarine, that it is a substance built up as it were from compounds less complex than itself by chemical reactions; how do you define madder alizarine?

A. As a body extracted from the madder plant in which it exists as a result of the vital process or processes involved in the growth and maturity of the plant.

x-q. 74. Will you say that madder alizarine is not built up from compounds more or less complex by chemical reactions?

673 A. In the sense in which I have used the words "chemical reaction" heretofore, I *should* say so.

x-q. 75. Without reference to the sense in which you have used the words mentioned, please answer the last preceding question.

A. Using the words "chemical reactions" in the proper and legitimate sense in which they are used by chemists, I should say that madder alizarine is *not* built up from compounds more or less complex by chemical reactions.

x-q. 76. Without reference to using the words "chemical reactions" in a proper or legitimate sense, will you please to answer x-q. 74?

A. As I am here to answer questions as a chemist and not to speculate as to the use of words in other relations, I do not consider it appropriate to attempt answering the question otherwise than in connection with the proper and legitimate use of words belonging to the science of chemistry.

x-q. 77. Will you say that madder alizarine is not in any sense built up from compounds more or less complex by chemical reactions?

A. In the sense in which the words might be used by a person ignorant of the science of chemistry, or having some special theory to support, this or any other erroneous statement might be made.

(Defendants' counsel objects to this answer as irresponsive and repeats the question and asks for a direct answer.)

x-q. 78. x-q. 77 repeated.

A. It is not in any proper sense.

x-q. 79. Is it so built up in any sense?

A. I do not consider myself competent to decide as to how far words may be used out of their proper signification.

x-q. 80. Are you very certain, professor, that madder alizarine is not in any chemical sense or in any other proper sense or in any way within your knowledge built up of compounds more or less complex?

A. I have never asserted anything of the sort. What I have asserted is that the statement that madder alizarine is built up from compounds more or less complex by *chemical reactions* would be a definition of it entirely untrue in view of the recognized meanings of the words employed in the science of chemistry and would convey an entirely false impression. Madder alizarine is undoubtedly built up in some sense from other bodies or elements in the process of growth, but by no means by chemical reactions.

x-q. 81. Have you experimented with madder alizarine with the view of discovering what the elements or bodies are of which it is built up?

A. I have not, but it is common knowledge that all vege-
674 table products are built up by the process of growth from carbonic acid, water, ammonia and small quantities of the solid constituents of the soil.

x-q. 82. Please define what you understand to be the elements or bodies in madder alizarine?

A. Carbon, hydrogen, and oxygen. If we mean the chemically pure extract, which may be obtained from madder root by certain elaborate processes of separation, we then consider it as composed of these three elements in the proportion of C_{14} H_8 O_4; but if we mean the available dyestuff which may be extracted from madder root, we have then in view a very complex mixture or compound of several dyeing elements in varying proportions, and consequently we cannot say generally of just what proportions of carbon, hydrogen, and oxygen it would consist, although mainly made up of these elements.

x-q. 83. To what extent have your experiments with madder alizarine gone; please state fully and particularly?

A. During the past year or more I have been constantly conducting, in my laboratory, processes of separation and purification of madder alizarine, having, in the first place, the object in view of preparing from madder some alizarine which should be strictly pure or should contain no trace of any other material. With this view, I have treated madder essentially by each of the processes described by Dr. Chandler in his testimony in the present case, and failing by any of these methods in obtaining a perfectly pure product, I then had recourse to the method recommended by Rosenstiehl and already quoted in my testimony. In this, purpurine (which I had found one

of the most difficult substances to remove by any of the other methods) is destroyed by heating the madder extract in dilute alkaline water in a closed vessel up to a temperature of 200 C, or hot enough to scorch a cloth laid on top of the boiler; the pressure inside under these circumstances was nearly 250 pounds to the square inch. The material left by this treatment was then extracted with hot kerosene, after Kopp's method, removed from the kerosene by an alkaline solution, precipitated by hydrochloric acid, sublimed, dissolved in alcohol, and crystallized.

In the course of these experiments I made constant tests by dyeing swatches with the products in their various stages of purification or separation, and with the various dyeing elements other than chemically pure alizarine, which I had separated out, and also I made constant examination of my products with the spectroscope, and by the application of such other tests as are given by the recent writers on this subject, such as solution in ammonia, precipitation as alumina, lime, and other lakes, and the like. In order that I might judge of the influence of purpurine, pseudo-purpurine, and so
675 forth, in the madder extracts, I also dyed swatches with these materials, separated out to a greater or less degree.

x-q. 84. Did you ever test madder alizarine for anthrapurpurine, isopurpurine, oxanthrachinone, or Perkin's orange matter, or for any of them?

A. I did not, for the following reasons: madder and its extracts have been investigated by the ablest chemists in the world for years, and they have failed to find in them any of these substances. I should have regarded a search in this direction, therefore, as about as sensible as looking for cognac in sea-water; moreover, the presence of these substances would have revealed itself in some of the many tests which I have applied, had they been present.

x-q. 85. Please give me the names of the "ablest chemists" who have tested madder alizarine for the products I have named, and state the substance of what each of them says on this subject, giving page, title, and date of publication of such statement.

A. The authors who have investigated the composition of madder and its extracts have been already named and extensively quoted from in my testimony and Dr. Chandler's. Such, for example, as Robiquet and Colin, Kopp, Rosenstiehl, and others.

Chemists are not in the habit of describing substances which they have not found and have no reason for looking for; for example, in an analysis of an iron ore, a chemist would not state that he had failed to find indigo, or lead, or gold, but his statement that he found it to consist of iron, carbon, and sulphur would be pretty good evidence that the other bodies were not there.

The statements already quoted, by their simple omission of any reference to the bodies you have named, afford, therefore, I consider, satisfactory evidence that they were not present.

x-q. 86. Will you please answer the 85th x-question in a direct manner, and give me the names of the "ablest chemists" who have

tested madder alizarine for anthrapurpurine, monoxanthrachinone, isopurpurine, and Perkin's yellow matter, with the title, page, and date of the publication wherein they state that they have so tested, and the results of their tests?

A. Cross-question 84 does not admit of a direct answer, because amongst other things it assumes, contrary to fact, that I have stated that eminent chemists have tested madder alizarine for certain substances named. I have asserted nothing of this sort. What I have asserted and do assert is that eminent chemists, to whom I have referred in my last answer, have examined madder alizarines, with a view of finding out what they did contain, and that their failure up to the present time to discover any of these bodies is to my
676 mind very strong evidence that they are not present. It seems to me that this is the most direct answer of which such a question admits consistently with the facts as I believe them to exist.

x-q. 87. Why was it that chemists did not report the presence of rubidium in beet juice till after Bunsen had detected it in mineral water, and taught how to distinguish it?

A. Because it was present in quantities so minute as to constitute only what is known as a trace, and entirely inefficient from this minuteness of quantity in effecting any of the properties or actions in reference to which beet juice had been studied.

x-q. 88. Why is it that chemists did not discover in what is known as Pollux mineral, the presence of cesium, which occurs in it in considerable quantities, until it was discovered by Bunsen in mineral water?

A. Because, I presume, in the first place, this mineral had not been very thoroughly studied by a number of eminent chemists, and, in the second place, because the existence of such a body as cesium had not been demonstrated at the time when any of these examinations were made. Without being able to say, without reference to some text book or other publication, positively, how this thing happened, I have little doubt that the first examination of this mineral made after the discovery of cesium by Bunsen, resulted in its recognition therein. In the case of madder alizarine, however, the most elaborate investigations, such as those of Rosenstiehl, have been made since the discovery of anthrapurpurine by Perkin, isopurpurine by Auerbach, and anthraflavic acid by Schunk.

x-q. 89. Can you say that Rosenstiehl made special tests with madder alizarine for the express purpose of finding in it anthrapurpurine, monoxanthrachinone, isopurpurine, and the other substances you have named, or that he made special tests to find in madder alizarine any one of them? If you say yes, will you please quote what he says about it, and give the date, volume, and page of the publication wherein he makes such statements; or if such statements are not published, give the source of your authority for what you have said concerning Rosenstiehl's experiments in this direction; a direct answer is requested?

A. It will give me extreme pleasure to give the most direct an-

swer of which the complex and to a certain extent erroneously suggestive character of the question admits.

In the first place, I cannot say that Rosenstiehl made special tests with madder alizarine for the detection of the substances you have named, and I have not asserted any such thing in my testimony heretofore. My reason for believing that Rosenstiehl would not have failed to recognize some, if not all of these bodies, is the following: He is a chemist of high repute in one of the prominent German schools, and has been for years devoting his attention to the study of these dyestuffs in a practical as well as a theoretical manner.

677 As appears from his researches, such as that described in the Moniteur Scientifique for 1875, pp. 562 to 570, he has had constant recourse to dyeing tests in the progress of his examination, and the behavior of iso and anthrapurpurine in the dye bath is so peculiar that I do not think an intelligent student could fail to recognize them (when their existence was once known,) when carrying on and carefully examining such tests, and the presence of monoxanthrachinone would be readily detected even in some of the imperfect processes for purification recommended by the early writers.

Adjourned to Monday, p. m., Oct. 16, '76—2 o'clock.

NEW YORK, *Oct. 16th*, 1876.

Continuation of the cross-examination of Prof. MORTON:

Present—Counsel as before.

x q. 90. Can you now, since the adjournment, quote any authority to the effect that tests had been made of madder alizarine to determine in it anthrapurpurine, monoxanthrachinone and isopurpurine, or any of them?

A. Having had no time at my disposal since the close of the last examination, made on Saturday afternoon, I can state nothing now that I could not have stated on a little reflection at the last meeting. I will, however, give a list of some of the authorities to whom I then referred, as follows:

Robiquet and Colin, Runge, Schunck, Debus, Wolf and Strecker, Rochleder, Schutzenberger, Higgin, Rosenstiehl, and Dr. Chandler in his testimony in this case.

Many of these authorities, as I have before stated in effect, took up the investigation of madder root and its extracts for the express purpose of finding out everything that it contained in the way of efficient dyeing elements, and even in many cases every material contained in it of every sort. As a result of this, a number of bodies were separated, examined, analyzed, and tested in countless ways. A pretty full list as to most of these is given in Dr. Chandler's answer to direct question 5. Dr. Chandler here gives a list of some twenty-seven materials as known to exist, and a list of seventeen which have been from time to time announced, but whose existence is more or less doubtful, and in reference to the entire list, says:

"Only three of these substances appear to play any part in dyeing and calico printing; these are alizarine, purpurine, and hydrate of purpurine."

678 Rosenstiehl names four coloring substances, alizarine, pseudopurpurine, purpurine and purpurine hydrate as universally admitted at the time of writing, June, 1875, as comprising the coloring substances of Alsace madder, and without going into the individual quotation of other authors, for the reason that I have not their works before me, I think that Rosenstiehl's statement above may be regarded as a fair expression of the results of investigations, whose printed records would, in the aggregate, constitute a very large volume; of these four substances, there is not one whose properties are not in the most marked way distinguished from those of anthrapurpurine, monoxanthrachinone and isopurpurine; and as two of these latter, viz., isopurpurine and anthrapurpurine, are dyestuffs fully equal in efficiency to alizarine, the failure to discover them on the part of these investigators, if they existed in the madder root or its preparations, would be simply incredible.

When answering on Saturday I omitted to mention one experiment of my own which would bear directly on the question here involved. I precipitated some madder extract as a lime lake, and washed it thoroughly. To the washings, or filtrate, I added hydrochloric acid; this precipitated a gummy or glutinous mass not in the least resembling the material obtained by a like treatment from artificial alizarine, and which in that case exists essentially of monoxanthrachinon. This glutinous substance dried on the filter to a very dark brown, almost a black, scale, which, when cautiously heated in a porcelain capsule on a sand bath, in the manner following for subliming alizarine, monoxanthrachinon and the other like bodies, yielded no subliment whatever, though it was finally heated to the point of carbonizing. Had there been any monoxanthrachinon present this treatment must certainly have resulted in the obtaining of some crystals of that substance by sublimation, and, therefore, remembering this test as I now do, I can say confidently, from my own experience, that madder and its extracts do not contain monoxanthrachinon. Moreover, if isopurpurine had been present, this should have dissolved out from the calcium lake to some extent, and its presence would have been manifested by the formation of a sublimate. As I have referred in a general way at the beginning of this answer to Dr. Chandler's opinion, I will here quote the questions and answers which I had in mind:

"x-q. 158. Are these things which in your answer 18 you have mentioned as impurities in artificial alizarine, found in any of the preparations of madder which you have mentioned in your answer 4?

"A. They have never been reported by any chemist as occurring there.

"x-q. 159. Are they found in any other preparations or extracts from madder?

"A. Not to my knowledge."

It by no means always follows that to prove the presence or absence of a substance a test must be applied with the express intention of answering that particular question, but in the course of a
679 thorough investigation as to the composition of a body, the strongest possible evidence as to all that is and all that is not in it, may be obtained, and when such an investigation is repeated during a long series of years by chemists of the highest ability, the cumulative evidence as to what is and what is not contained in the substance examined becomes really more weighty than that which would be obtained by the application of a direct test in reference to any one element by a single experimenter. This I conceive to be the case in a pre-eminent degree in the present instance, and that to enter upon the elaborate series of investigations which would be needed if it were hoped to add anything to our present knowledge on this subject, would be like entering upon a similar search for the philosopher's stone or any other scientific mare's nest.

x-q. 91. You have quoted among your authorities Dr. Chandler's answer to the 158th cross-question, concerning the presence of anthrapurpurine, monoxanthrachinon and isopurpurine in madder alizarine in these words: "They have never been reported by any chemist as occurring there." Do your researches confirm him in this statement?

A. They do. I must, however, in reference to the earlier part of your question, explain that I do not quote Dr. Chandler in the same sense that I quote the authors of researches on madder and its preparations, but as stating his summary of their published results.

(Defendants' counsel objects to all that part of the answer after "I do" as irresponsive.)

x-q. 92. Have you examined the several authorities named by you in your last preceding answer on the subject of alizarine, its derivatives and distinguished characteristics?

A. I have.

x-q. 93. Will you say positively that it is within your knowledge that anthrapurpurine, monoxanthrachinon and isopurpurine do not exist in any degree in madder alizarine?

A. If by the term madder alizarine we understand the substance which that term would indicate in a work upon pure chemistry, that is to say, the substance chemically pure alizarine obtained from madder, I should say that my knowledge that these bodies did not exist in it was of the most positive character possible. If by madder alizarine we understand one or another of the madder extracts commercially prepared, sold and used as alizarines, I should say that, having reference to monoxanthrachinon, my knowledge was of the same absolute character, in reference to the madder alizarine which I have myself examined.

In reference to isopurpurine, my confidence is almost as positive, and in reference to both iso- and anthrapurpurine, I consider my knowledge of their non-existence to be only inferior to that
680 absolute knowledge already mentioned, in so far as all knowledge derived by deduction from experience, other than our

own, is inferior in certain cases to the knowledge obtained by the direct use of our own senses.

x-q. 95. Will you say that chemically pure artificial alizarine, or such as a work on "pure chemistry" would call chemically pure alizarine, has in it anthrapurpurine, monoxanthrachinone and isopurpurine?

A. Your question implies that the words chemically pure artificial alizarine would be synonymous with chemically pure alizarine, if the latter phrase were used in a work on pure chemistry. This, however, is not correct; the words "chemically pure alizarine," occurring in a work on pure chemistry, might mean either a substance extracted from madder and giving the chemical formula $C_{14} H_8 O_4$, or one extracted from artificial alizarine, and giving the same formula, or being, in other words, isomeric with it, and having properties so closely alike that no distinction has yet been perceived between them. Neither of these bodies, in a theoretically pure state, could possibly contain any of the substances you have named, that is, anthrapurpurine, monoxanthrachinone or isopurpurine.

x-q. 96. Did you ever extract alizarine from the crude madder root?

A. I have not extracted it from the crude root, but I have extracted it from garancine, which, as is well known, has lost nothing except certain mineral and unimportant organic materials.

(All after "crude root," objected to by defendant's counsel as irresponsive.)

x-q. 97. Did you ever make garancine from the crude madder root?

A. I did not.

x-q 98. Now, since you have never made alizarine from the crude madder root, nor made garancine from the crude root, will you say positively that it is within your knowledge that alizarine extracted from the crude root, or from garancine from the crude root, would not contain anthrapurpurine, monoxanthrachinone and isopurpurine?

A. Using the term alizarine in its proper chemical signification, I should say that the assertion that it contained anthrapurpurine, monoxanthrachinone or isopurpurine, would be simply a contradiction in terms, whether I had ever made it or seen it, or knew anything about it beyond what was to be found in an elementary work on chemistry, since the word alizarine in its scientific chemical sense means one body; anthrapurpurine means another body; monoxanthrachinone means yet another body; and isopurpurine means still another body.

x-q. 99. Hitherto when you have referred to alizarine and the three substances we have been talking about, had you reference in a strictly scientific and chemical sense?

A. Generally, except when the context indicated otherwise. The term alizarine has in common use a strict chemical and a
681 commercial signification, but the context, as I believe has

been the case in my own testimony, rarely if ever fails to show in which of the two senses it is used.

Adjourned to Tuesday, October 17, 1876, at 11 o'clok.

OCTOBER 17, 1866, 11 a. m.

x-q. 100. How would you proceed to detect the presence of anthrapurpurine in madder alizarine?

A. This is a question to which it would be impossible to give off hand anything like a complete answer. If I were to enter upon the investigation, I should begin by making some such experiment as that of treating madder extract, which is what I understand in this case by madder alizarine, in the same way Perkin treated artificial alizarine, and I would be guided by the result that I obtained as to my next step. I refer to Perkin's papers published in the Quarterly Journal of the Chemical Society of London.

x-q. 101. Professor, do you regard alizarine and anthrapurpurine as two separate and distinct dyeing principles, each possessing separate and distinct characteristics?

A. I do, understanding these words in their chemical sense.

x-q. 102. Do you regard monoxanthrachinone as a dyeing principle, and whether it is dyeing principle or not, has it distinguishing characteristics separate and apart from the characteristics by which alizarine is recognized?

A. I do not regard it as a dyeing principle, although it may have an influence in the dyebath, such as helping to keep the whites clean. Its properties are in the most marked degree, therefore, different from those of alizarine, either pure or in any of its ordinary commercial preparations.

x-q. 103. Do you regard isopurpurine as a dyeing principle, having characteristics distinct from those of alizarine?

A. I do.

x q. 104. Is or is not anthrapurpurine prepared and sold as a dyeing principle apart from alizarine?

A. Not to my knowledge, though it is very possible that a commercial article may be manufactured and sold under that name, and indeed I think that one of the grades of artificial alizarine has been so called.

x-q. 105. Do you know what "scarlet alizarine" is?

A. I am not certain that I know it by that name, but I have examined a specimen of alizarine manufactured by complainant's company, which gives a very scarlet shade with alumina mordant, and which I presume may be the same thing.

x-q. 106 Do you know what is known as "purple shade alizarine?"

682 A. I cannot say that I recognize it by that name, but I have examined specimens of artificial alizarine which give purplish reds with alumina mordant, and which I have no doubt are essentially the same thing.

x-q. 107. Can you distinguish chemically pure madder alizarine from chemically pure anthracene alizarine?

A. I cannot.

x-q. 108. Do you or do other chemists who have investigated the subject now doubt the absolute identity of chemically pure madder alizarine and chemically pure anthracene alizarine, so far as you know?

A. If by absolute identity you mean that they may not be such isomers as are, for example, the orthometa and para forms of cressol, that is, consist of molecules in which the hydroxyl or oxygen groups are attached to different angles of the hexagon of the carbon radical, I think, myself, that it is quite probable that they may be such isomers, and not absolutely identical, and some of the latest speculations of Perkin and of Schunck look this way. But for practical purposes, as elements in a complex commercial dyestuff, they may be and are regarded as identical.

x-q. 109. In criticising the testimony of Dr. Chandler, when you differ from him as to the identity of madder alizarine and anthracene alizarine, do you mean by the word alizarine chemically pure alizarine, or a mixture of this with other substances?

A. I think that in each case I have very clearly stated the sense in which I used the word or considered it to be used in the passage criticised, but I will state generally that wherever the word was used to signify chemically pure alizarine, I entirely agreed with Dr. Chandler as to its practical identity, whether obtained from madder extracts or from artificial alizarine.

x-q. 110. How would you detect anthrapurpurine and isopupurine when mixed with considerable quantities of alizarine and purpurine?

A. By separating them out more or less perfectly, as might be required, by methods of Perkin and Auerbach, by applying their test, and by such other experiments as the results so obtained would suggest.

x-q. 111. You succeeded in obtaining chemically pure alizarine from madder alizarine, did you not?

A. I did.

x-q. 112. Then there is no obstacle which prevents the obtaining of pure alizarine from madder?

A. I do not think this follows. It is one thing to vanquish an obstacle and to obtain a result notwithstanding, and another thing to find no obstacle. Serious obstacles existed to the foundation of the American Government, which nevertheless exists.

x-q. 113. You overcame the obstacles you found to exist, when obtaining pure alizarine from madder?

683 A. At the expense of a vast amount of time, labor and material, and with the destruction of a greater part of the alizarine operated upon, I did.

x-q. 114. Did not Dr. Chandler in his testimony state that the madder root, flowers of madder, garancine and madder extract contained purpurine?

A. He may have done so, but I do not recall the passage at the present moment. On reference to the record, however, I find question 5 in his evidence to read as follows: "Q. 5. What is madder, its composition, its derivatives, and its application to the arts?"

In the answer to this question, Dr. Chandler names purpurine in his list of substances found in madder after drying and curing, and also cited purpurine as one of the only three substances which appear to play any part in dyeing and calico printing.

x-q. 115. Did not Dr. Chandler, in his testimony, state that alizarine made from anthracene contained anthrapurpurine?

A. I find in the record question and answer 18 to read as follows: "Q. 18. What are the impurities in alizarine extracted from coal tar or atificial alizarine?" "A. The impurities in artificial alizarine are anthracene, anthraquinone, oxanthraquinone, anthraflavic acid, anthrapurpurine, a yellow compound which dyes cotton mordanted with alumina of an orange tint, &c." I would draw attention here to Dr. Chandler's judicious discrimination in excluding from his answer that part of the question which inquires about alizarine extracted from coal tar, as of course there could be no such thing, as coal tar does not contain any alizarine.

x-q. 116. How, then, can you say, as you do in your answer to question 44, that Dr. Chandler assumes that artificial alizarine consists of nothing pure alizarine, or in your answer to question 45, that "he assumes that madder extracts in use prior to 1869 were pure alizarine?"

A. Because in these respective questions I am not asked anything in reference to Dr. Chandler's testimony at large, but only in reference to his answers therein specified.

Now these particular answers either assume what I have stated, or they are so contrary to the facts of the case that I could not for a moment accuse Dr. Chandler of intentionally making such statements.

x-q. 117. Does pure alizarine give "very beautiful violets," as Schutzenberger says, as you quote him in your answer to question 30?

A. It does.

x-q. 118. Is pure alizarine a fast dye?

A. It is.

x-q. 119. Is it true, as Napier says in your quotation of him, given in your answer to question 30, that it was afterwards found that a fixed dye could not be obtained with pure alizarine?

A. I do not think that statement is correct, although it is
684 given in the old edition of Napier, the error being in the use of the word "fixed" in place of available or desirable or some such term, in the sense of something equivalent to the usual madder extracts.

x-q. 120. Can you not dye mordanted cotton cloth with chemically pure alizarine, and have you not furnished exhibits so dyed?

A. You can, and I have.

x-q. 121. You say "alizarine is not a practical dyestuff." Do you

mean that it does not produce fast colors on cloth mordanted with alumina and iron, or that the tints are not as handsome as those produced by mixtures of alizarine with purpurine and anthrapurpurine or isopurpurine?

A. I have said that chemically pure alizarine is not a practically available dyestuff, similar in its effects to the commercial extracts of madder. By this I mean that while it will produce fixed colors with alumina and iron mordants, these colors will be very different from those produced by the commercial extracts of madder. That this difference will be in a direction injuring the clearness or purity of tint in the reds and pinks, which are the most important madder colors. That, moreover, pure alizarine will combine with the unmordanted parts of the cloth in such a way as to resist the ordinary cleaning and soaping treatment, which is not the case with madder extracts. This is what I have said in the passage referred to, and I will further add in reference to your question that the tints produced on mordanted cloth with pure alizarine are not so handsome as those which can be produced with some mixtures containing in addition purpurine or anthrapurpurine and isopurpurine.

x-q. 122. Will you say that indigo is not a practical dye, because it will not produce a pink or red?

A. No, but I would say that if purified indigo failed to produce a good blue, it would not be a practically available dyestuff similar in its effects to commercial indigo, or capable of replacing the same as a dyestuff, even though it should produce the finest possible reds and pinks.

x-q. 123. Will you say aniline violet is not a practical dye because its tinge is not orange or yellowish?

A. No; but I would say that if chemically pure aniline violet differed from commercial aniline violet when used as a dyestuff by yielding an inferior violet shade, I should say that it was not a practically efficient dyestuff, as a substitute for the commercial material, but would simply be a practically worthless material as a dyestuff, since it would be inferior in the only point under consideration to the commercial article.

x-q. 124. You have quoted Mr. Perkin repeatedly as an authority in your testimony in this case. Do you regard him as a high authority, and is the Perkin you quote William Henry Perkin, a Fellow of the Royal Society, London?

A. I regard him as a high authority in reference to the
685 investigations on chemical subjects which he has made and published. It is, however, well known that he is one of the patentees in connection with the manufacture of artificial alizarine, and a certain allowance must be made in any case where his speculations might be influenced by his individual interest. He is the William Henry Perkin named by you.

x-q. 125. Would you consider any published statement of his relating to alizarine or its derivatives as entitled to great weight?

A. If it was a statement of fact within his knowledge, I would.

If it was a speculation, where we could see that his individual interest would naturally lead him to take the view expressed, I should give it very little weight.

x-q. 126. Is he not regarded as one who is peculiarly familiar with alizarine, its properties and composition?

A. By no means. As compared with any of the list of investigators on madder and its extracts given by me in my answer 90, I should say that he held an equal, or in some cases an inferior rank. He has studied artificial alizarine and identified one of its constituents, anthrapurpurine, and also recognized in it what he calls an orange matter. He has also been engaged in the manufacture of artificial alizarine, from which I am informed he has recently retired.

x-q. 127. Do you regard him as an authority concerning the properties and constituents of artificial alizarine?

A. To a certain extent. He recognized and isolated anthrapurpurine; he did not recognize isopurpurine, and I am not aware that he has made any investigations on the subject since those on anthrapurpurine which I have largely quoted.

x-q. 128. Do you regard him as an authority on the identification of anthrapurpurine in alizarine?

A. I do.

x-q. 129. Do you know of any better authority than he on this subject?

A. I do not.

x-q. 130. Are you aware that on the 14th of last month he published the following statement in an opening address delivered by him before the British Association, and reported in the publication called "Nature," as follows: "It was observed that when commercial artificial alizarine prepared from anthrachinone, but more especially from di-chloranthracene, was used for dyeing, the colors produced differed from those dyed with madder or pure alizarine, and many persons, therefore, concluded that the artificial coloring matter was not alizarine at all. This question, however, was set at rest by separating out the pure artificial alizarine from the commercial product and comparing it with the natural alizarine, when it was found to produce exactly the same colors on mordanted
686 fabrics, to have the same composition, to give the same reaction with reagents, and to yield the same products upon oxidation. * * * * The commercial product called artificial alizarine, first supplied to the consumer, was always a mixture of alizarine and anthrapurpurine, and various mixtures of these two coloring matters are still sent into the market, but owing to the investigations which have been made, and the study and attention which has been given to it by manufacturers, nearly pure alizarine and anthrapurpurine are also sent into the market, the first being known as blue shade alizarine, and the second as red or scarlet alizarine. The formation of anthrapurpurine in the manufacture of alizarine may, to some extent, be said to have arisen from a want of knowledge of the true conditions required for the production of the latter. * * * *

The discovery of the artificial formation of alizarine was of great interest, as it was another of those instances which have of late years become so numerous, namely, the formation of a vegetable product artificially, but the process used by Graebe and Liebermann was of little practical value on account of the difficulty and expense of working it." * * * * * In speaking of anthrapurpurine he also says: "This substance when investigated was found to have the same composition as purpurine, also a coloring matter found in madder."

A. I am aware that such an address was delivered and published, and had I considered that it added anything to what I already had introduced in evidence on the subject matter it contains, I should have added it to my own testimony. As a matter of fact, however, except that it is a report of an oral address, and thus contains some rather loose, inaccurate and not carefully considered statements, and as I shall presently point out, some which indicate a little personal feeling, such as might be expected from a commercially unsuccessful inventor and manufacturer, against his more successful rivals, it agrees entirely with what I have already quoted from this same author and others, and endeavored to make clear in my testimony. Thus, in the first place, Perkin and others had long ago stated, and I have frequently repeated, that the colors produced by commercial artificial alizarine differed from those produced by pure alizarine obtained from madder.

This is in substance the first of his statements just quoted by you.

The next statement is that chemically pure alizarine, extracted from the artificial alizarine, was found to produce the same effect and to have the same properties and composition as the chemically pure madder alizarine. This also has been conceded on all sides.

The next statement is that the "artificial alizarine first supplied to consumers was always a mixture of alizarine and anthrapurpurine."

That this was the case has been repeated by me, while
687 at the same time it is also evident that this was not known until anthrapurpurine was isolated and examined by Perkin as described in his paper which I have quoted.

The next statement is in effect that the manufacture has been improved in the direction of so modifying the original process as to develop at one time a product rich in anthrapurpurine, and at another time one rich in alizarine. This is nothing more than is stated in the quotation which I have made from the "Handbuch der Chem. Technologie," in my answer 29, folio 210, and I have also illustrated the same thing in the results of my own experiments.

Perkin, however, in omitting all reference to isopurpurine, and in speaking of the commercial products as nearly pure alizarine and anthrapurpurine, is speaking in a manner suitable for a mere popular oral address, but not in a way which adds anything to the accurate statements upon these subjects which I have already given.

His next statement, that the formation of anthrapurpurine in the

manufacture of alizarine may to some extent be said to have arisen from a want of knowledge of the true conditions required for the production of the latter, certainly adds nothing to our knowledge, while it looks a little like an unamiable reflection upon those who, whether they knew why or not, undoubtedly succeeded in obtaining a most valuable practical result.

His next statement, that the process used by Graebe and Liebermann produced a vegetable product, and was of little practical value, is curiously inconsistent with his former statement that all artificial alizarine contains anthrapurpurine, which is certainly not a vegetable product, and with the fact that Graebe and Liebermann, with their associates, have been and are the most successful manufacturers of artificial alizarine up to and at the present time.

The next statement, that anthrapurpurine was found to have the same composition as purpurine, is simply a repetition of what he had published orignally in 1872, and which no one has ever denied, but, of course, this no more proves any practical similarity between the two than does the identity in composition between the anthraflavic acid, described by Perkin as an isomer of alizarine, and which has no tinctorial properties, prove any practical similarity between *these* two substances. Bodies of the same composition, or, as they are termed, isomers, are exceedingly common in chemistry, and are often as unlike each other as the three forms of the same element, carbon, namely, the diamond, blacklead and coal. Thus we have, as isomers, otta of roses and oil of wormwood; starch and cotton fibre; or, as a more extended list, butyric acid, acetic ether, aldehyde and oxide of ethylane.

Adjourned to Saturday, October 21, 1876, 11 a. m.

688 NEW YORK, *Oct.* 21, 1876, 11 o'clock a. m.

Cross-examination of Prof. MORTON continued.

Present—Counsel as before.

The witness desires to correct his answer to cross-question 104, in the following respect: He there stated that he thought that one of the grades of artificial alizarine had been called anthrapurpurine; what he had in mind when making that statement, was a bottle containing apparently some form of alizarine paste with the printed label of Meister, Lucius and Brüning, and with the further title, which on referring to it again he finds to be "isopurpurine," and not, as he supposed before from imperfect recollection, anthrapurpurine.

Counsel for defendants objects to all that part of the witness Morton's answer to the 130th cross-question that follows the statement "I am aware that such an address was delivered and published" as irresponsive.

x-q. 131. Will you oblige me by stating all the substances as well as the elements that are found in artificial alizarine, also in madder

alizarine, so far as they are within your knowledge; I mean the commercial alizarine of both kinds?

Artificial Alizarine.

CHEMICALLY PURE ALIZARINE of the formula $C_{14}H_8O_4$.

MONOXANTHRACHINONE of the formula $C_{14}H_8O_3$.

ANTHRAFLAVIC ACID, having the same formula as alizarine, but totally unlike it, having no tinctorial properties whatever.

ISOANTHRAFLAVIC ACID, also having the same formula as alizarine, but differing from it by having no tinctorial properties and being distinguished from anthraflavic acid by certain reactions.

ANTHRAPURPURINE, having the formula $C^{14}H^8O^5$, in other words, isomeric with purpurine and having likewise tinctorial properties which are, however, entirely different from those of purpurine.

ISOPURPURINE, having the same formula and having also
689 tinctorial properties which are, however, quite distinct from either those of purpurine or anthrapurpurine.

FLAVOPURPURINE, a body having the same formula as the above, but distinguished from it by certain reactions and especially by its absorption spectrum.

PERKIN'S ORANGE, MATTER, which has not yet been analyzed.

ANTHRACHINONE.

ANTHRACENE, and various mineral and other accidental impurities, such as soda.

Madder Alizarine.

CHEMICALLY PURE ALIZARINE of the formula $C^{14}H^8O^4$.

PSEUDOPURPURINE, whose formula is $C^{14}H^8O^6$, a substance which possesses strong tinctorial properties, producing rich colors with the usual mordants, which, however, wash out with clearing and soaping.

HYDRATE OF PURPURINE, which yields tolerably fast colors with mordants after the action of boiling soap.

XANTHOPURPURINE, whose composition is $C^{14}H^8O^4$, which does not possess tinctorial properties.

PURPURINE, whose formula is $C^{14}H^8O^5$, the same as that of anthrapurpurine and isopurpurine, and which, like them, produces colors with alumina and iron mordants, but of shades readily distinguishable and much less fast or resistant to washing with soap.

GREATER OR LESS QUANTITIES of wood fibre and various practically unimportant organic or inorganic compounds, such as glucose, cane sugar, gum, mucilage, albumen, erythroxyn, pectin, pectic acid in combination, chlorogenin, citrates, malates, taltrates, oxyilates, sulphates, phosphates, chlorides, potassium salts, sodium salts, calcium salts and magnesium salts.

The presence or quantity of these unimportant substances depending upon the character of the commercial alizarine considered. The purer forms having no doubt only traces of some and no appreciable quantities of others.

In the above lists I have given all the substances which I can at this time recall.

I should also remark that all of the important substances named would not be found in all the madder alizarines; thus pseudopurpurine, being decomposed by a high temperature or converted into purpurine and xanthopurpurpurine, would not be found in a madder extract which had been highly heated.

x-q. 132. Does that same remark apply in any degree to artificial alizarine?

A. I think not; that is to say, I do not know of any similar decomposition or change in the case of artificial alizarine which would do more than modify the proportions of the various constituents, giving us in such case an artificial alizarine richer in one or another constituent.

x-q. 133. Of all the substances named by you in both the artificial and madder alizarines, including alizarine itself, which is of the most importance to the dyer; I am speaking now of commercial alizarines?

A. If, when you say "alizarine itself," you mean commercial alizarine, the question is self-contradictory, the entire list of substances being, as appears from your question 131, commercial alizarines. But alizarine itself, if by this is meant, as thus appears, the entire mixture known as artificial alizarine, or the other mixture known as madder alizarine, is more important to the dyer than any one of its dyeing elements Between the two—the artificial alizarine and madder alizarine—experience seems to have decided unequivocally in favor of the former, as it has almost driven the other from the market.

690

x-q. 134. Will you say that artificial alizarine has almost driven madder alizarine from the market, and do you make that assertion as a fact derived from your own knowledge?

A. From my own knowledge, as derived from the published statements of those who I believe are well informed on the subject. In the address of William Henry Perkin, from which you have already quoted from the journal "Nature," Sept. 14, 1876, on page 434, I find as follows: "During the ten years immediately preceding the introduction of artificial alizarine the average annual imports of madder into the United Kingdom were 15,292 tons, and of garancine 2,278 tons, and * * * the annual value in round numbers was about 1,000,000 sterling. * * * The money value, which was formerly 1,000,000 pounds per annum, is now, calculating from the estimated quantity of this year, only at 138,105 pounds."

Testimony to this same effect has, I think, already been introduced in Dr. Chandler's evidence.

x-q. 135. Is it not a fact that artificial alizarine can be and is produced at much less cost than madder alizarine?

A. It is, and it is also a fact that it is much more efficient in dyeing and calico printing for a number of purposes than is madder alizarine.

(All after "It is" is objected to by defendants' counsel as irresp onsive.)

x-q. 136. Now, when you quote from "Nature," as you have done, and when you speak of other publications in a general way without naming them, is the information so stated by you all that you know about artificial alizarine "having almost driven madder alizarine out of the market;" a direct answer is requested?

A. By no means. I am well acquainted with Mr. Hunter, the owner and manager of a very large print works near Philadelphia, who was the first, I believe, to introduce artificial alizarine practically in this country. I frequently conversed with him in former years, when he was making experiments in this connection, and have recently visited his works, where I saw large dye vats, formerly used for madder preparations, lying idle. In connection with questions on this subject, he explained that it was much more profitable for him to abandon the large large amount of capital thus represented,
and to do all the work for which it had been before employed
691 by direct printing, which was rendered possible by the employment of artificial alizarine.

x-q. 137. Have you stated all you know about artificial alizarine having almost driven madder alizarine out of the market?

A. With the exception that I found it extremely difficult, and, indeed, almost impossible some time since to find in the market some of the formerly most popular madder extracts, such as pinkoffin and green alizarine, and that I have read and heard in so many places the statement that artificial alizarine had practically driven madder alizarine out of the market, that I should regard this as a matter of common knowledge; I have stated all that I now recall upon the subject

x-q. 138. Then, as a matter of fact, the statement made by you that artificial alizarine has "almost driven madder alizarine from the market," was stating as a fact a thing of which you had nor personal knowledge; wasn't it?

A. In the same sense as stating that Ulysses S. Grant is President of the United States is stating a fact of which I have no personal knowledge—it is.

x-q. 139. Referring to the questions and your answers in this record, wherein you state concerning certain spectra named and illustrated by you, please tell me if you have also experimented with alizarine containing anthrapurpurine or with anthrapurpurine separate from the alizarine; and if yes, with what result?

A. I have, and find that they do not make solutions in alum water which are permanent; that is, they dissolve to a certain extent while boiling, but deposit entirely on cooling. When in solution they show no absorption bands. I did not put in specimens simply because they would have been merely bottles of alum water with an undissolved precipitate, but would be happy to produce the materials and demonstrate the action if desired.

x-q. 140. As to isopurpurine and monoxanthrachinon combined with and without alizarine, have you made spectra?

A. I have made experiments showing that under the conditions

in which these absorption bands are obtained with madder and its extracts, none are shown with any of these substances you have named, either alone or mixed together.

HENRY MORTON.

692 NEW YORK, *October* 23, 1876, 3 o'clock p. m.

Cross-examination of Prof. MORTON continued.

Present—Counsel as before.

x-q. 141. Please give me the dates of the discovery and identification of anthrapurpurine and isopurpurine, in artificial alizarine, and by whom they were discovered?

A. A substance is understood among chemists to be discovered when it is isolated and its characteristic properties are desceribed and published; in this sense anthrapurpurine was discovered by Perkin, in 1872, and isopurpurine, by Auerbach, in the same year. Perkin, in 1870, had already announced his observation of a new dyeing material in artificial alizarine, but he had not then isolated it or made any analysis. Koechlin, in 1869, had recognized the novelty of the artificial alizarine, as I have already quoted in my previous testimony on page 54, but neither of these earlier observations can can be properly considered as representing the discovery or isolation of these bodies. The words of Koechlin are:

"I have the satisfaction to announce to you that the artificial alizarine which you have sent me has yielded on trial colors superior to those of madder and to its commercial derivatives. These colors exhibit new qualities. They differ from those of purpurine, and fortunately have nothing in common with those of alizarine. The reds are more scarlet, the chocolates are richer, the iron mordants are better dyed. It is madder under a new constitution, uniting at once and in a marvelous manner the qualities of alizarine with those of purpurine, with one exception only, in reference to the pinks, which incline to yellowish, a question of perfection for the developing of alizarine.

"Although this synthetic rival which comes from the factory of Meister Lucius is not for sciences the alizarine of the alizaris, a coloring matter which is produced at a low temperature, it is for industry infinitely more than that alizarine; it is the madder of the future, and by general consent it is the solution of the problem of Laurent. The alizarine, or rather the artificial madder of Meister Lucius, is in the state of a paste which represents five times the tinctorial power of madder. By sublimation it yields needles shorter and paler than those of alizarine, and which give with the alkaline reagents the coloration proper to purpurine, while at the same time it is not purpurine.

693 x-q. 142. Is anthrapurpurine so called because it is made from anthracene?

A. There is no rule in chemistry as to such names, which are

what we may call fancy names given arbitrarily by discoverers. The chemical name of this body as a derivative of anthracene is trioxanthrachinone. In naming it anthrapurpurine, Perkin probably had in view in the first part of the name the fact that it was produced from anthracene, and in the second part, that it yielded as a dyeing substance reds somewhat resembling those produced by purpurine.

HENRY MORTON.

694 United States Circuit Court, southern district of New York.

BADISCHE ANILINE AND SODA FABRIK
vs.
JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE, AND JOHN SIMPSON. } In Equity.

It is hereby stipulated and agreed by the respective parties in this suit as follows:

The defendants hereby stipulate and agree that the testimony of John M. Ordway and James Harley, taken at Boston, Mass., on the 4th and 5th days of December, 1876, and the testimony of James Hunter and Carl Pickhardt, taken at New York December 8th and 9th, 1876, in the suit of the same complainants against A. Cochrane, Hugh Cochrane, and Carl Rumpff, copies of which testimony have been delivered to G. M. Plympton, esq., counsel for the defendants in this suit, shall be admitted as direct testimony in this suit, subject to the right of defendants' counsel to cross-examine the said witnesses.

The parties—complainant and defendant—hereby further stipulate and agree that the defendants shall have until February 1st, 1877, to put in their testimony in defence in this suit, and that the complainants shall have until March 1st, 1877, to put in evidence in rebuttal of defendants' testimony.

New York, Jan'y 9th, 1877.

J. VAN SANTVOORD,
Sol'r for Compl'ts.

G. M. PLYMPTON,
Sol'r and of Counsel for Defend'ts.

695 Circuit Court of the United States, southern district of New York.

BADISCHE ANILIN AND SODA FABRIK
v.
A. COCHRANE et al.

Circuit Court of the United States, district of Massachusetts.

BADISCHE ANILIN AND SODA FABRIK
v.
HAMILTON MANUFACTURING COMPANY.

EVIDENCE FOR COMPLAINANTS.

Taken pursuant to the sixty-seventh rule of the Supreme Court of the United States in equity, as amended, before me.

JOHN G. STETSON,
Examiner.

BOSTON, *Dec.* 4, 1876.

Present: J. Van Santvoord, esq., of counsel for complainants; E. N. Dickerson, esq., of counsel for defendants.

Deposition of John M. Ordway.

Direct examination by J. Van Santvoord, esq., of counsel for complainants:

Q. 1. Please state your name, age, residence, and occupation.

A. John M. Ordway; 53; Boston, Mass.; professor of industrial chemistry and metallurgy in the Massachusetts Institute of Technology.

Q. 2. What opportunities have you had of becoming practically acquainted with the processes used in the arts of dyeing and calico printing?

A. From boyhood, I have associated with those who were engaged directly in the various processes of calico printing. As a manufacturing chemist I have been brought into relations with the
696 printers. For six years I was connected with the Manchester Print Works in Manchester, N. H., first as a chemist, next as a manager, and finally as superintendent.

Q. 3. What experience have you had in giving testimony as an expert in patent suits?

A. I have several times been employed as an expert in cases relating to chemical patents, and have often been consulted as to the specifications of chemical patents.

Q. 4. Have you read, and do you understand, the patent of complainants marked Exhibit A, being reissue No. 4321?

A. I have read the specification of that patent, and believe I understand the purport thereof.

Q. 5. What do you understand to be indicated by the word "alizarine" as therein used?

A. I understand a substance which can be employed in the same manner and for the same purposes as madder, or the different preparations of madder, the word alizarine being sometimes used as a generic term to designate the coloring matter of madder.

Q. 6. Do you understand that this word as used in said patent necessarily implies that the product therein described contains anything found in madder root or its preparations?

A. There is nothing in this specification which intimates that the artificial alizarine therein described is the same alizarine which is contained in madder, or that it bears any other relation to madder than being capable of taking its place as a dyestuff.

Q. 7. What was the signification of the word alizarine as used by those skilled in the art of dyeing and calico printing prior to the date of the patent above referred to?

A. For a long time the word alizarine was used among printers and dealers in dyestuffs to indicate that preparation which was made by Messrs. Pinkoff and Schunk, which is sometimes called "Pinkoffin." It was afterwards used with the prefix "green" to designate a preparation of madder made according to a process devised by Amile Kopp. In confirmation of the former statement, I will refer to a lecture on "Coal Tar Colors and on Recent Improvements and Progress in Dyeing and Calico Printing," by Dr. F. C. Calvert, which was published over ten years ago. In this publication specimens dyed with Pinkoffin are to be found on page 5, and marked "Specimens of Alizarine Styles."

Q. 8. Have you examined any of the contents of the bottle marked "Artificial Alizarine, Exhibit Browne No. 1, J. G. S., examiner," for the purpose of ascertaining what those contents are, and, if yea, what do you find the same to be?

A. I have examined the contents of that bottle, and find it to correspond in appearance and character with other specimens of
697 artificial alizarine found in commerce.

Q. 9. Have you examined the artificial alizarine prepared in accordance with complainants' patent, and also the various commercial preparations of madder, with a view of determining their relative efficiency as dyestuffs? and, if so, please state the results of your examination.

A. I have examined a specimen of crude artificial alizarine, sent me by Mr. Carl Pickhardt, and said to be made exactly according to the original specification of Graebe and Liebermann, and according to the reissue No. 4321, dated April 4, 1871, Exhibit A, in this case; also, artificial alizarine V D; also, the artificial alizarine D; the artificial alizarine of Exhibit Browne No. 1, all of which were sent me by Mr. Carl Pickhardt. I have examined also the flowers of madder, the commercial alizarine, the garancine of commerce marked V C, as well as Meissonier's extract of madder, all of which were sent me by Mr. Carl Pickhardt. I have made comparative

dyeing tests with all these articles and with other artificial alizarine found in commerce, and with garancine made at Tiel, in Holland, and with Hunter's extract of madder, and with Kopp's green alizarine. I find that in respect to fastness the colors produced by the artificial alizarines are superior to those produced with the preparations of madder, and in respect to brilliancy they are by no means inferior.

Q. 10. Did you find any difference between the various specimens of artificial alizarine, which you have named in the previous answer, as regards their effects in dyeing?

A. I find some difference in respect to the tints produced with the different mordants, and but little difference with respect to fastness.

Q. 11. Did you find any difference in reference to the tints produced by the various madder preparations named by you in answer to interrogatory 9?

A. I found considerable difference in the tints produced and in the fastness of the colors.

Q. 12. Do you consider all the artificial alizarines, named by you in answer to interrogatory 9, equally good, or in other words equal in quality or efficiency as dyestuffs?

A. Not precisely equal but nearly so, as some are a little thicker than others, and probably contain a little more of the coloring matter.

Q. 13. What can you say respecting the novelty of the artificial alizarine described and claimed in complainants' patent, Exhibit A?

A. I consider this to be an entirely new product, and according to my reading it has been universally admitted by chemists to be a new and very valuable discovery, and that the credit of this discovery is due solely to Graebe & Liebermann.

698 Q. 14. What has been the result of this invention of Graebe and Liebermann in connection with the industries of dyeing and calico printing?

A. It bids fair to revolutionize the whole business of calico printing so far as the so-called madder styles are concerned. It enables us to obtain purer colors with much greater ease in the manipulation, and consequently, so far as the work is concerned, at a lower cost.

Q. 15. Do what you have described as madder styles constitute an important item in the product of print works?

A. By far the largest part of all the calicoes sent into market have been produced by the madder style, and the only prints which have remained prominently in demand are generally known as madder prints.

Q. 16. Will you please describe briefly the main features of the method by which these madder styles were produced prior to the introduction of artificial alizarine, and then the method by which they are produced with the aid of this dyestuff?

A. In the madder style the mordants are first thickened with starch or gum, and printed on the cloth. The cloth is then dried at a high temperature. It is then exposed for a short time to a warm, damp atmosphere in the so-called aging box. It is then exposed to the air in an aging room for several days, in order to allow the mordant to combine more intimately with the fiber. The cloth is then passed through a solution of cow dung, or of arseniate of soda, or of silicate of soda, to remove the gum and leave the mordant in combination with the fiber. It is then dyed with madder, or garancene, or commercial alizarine, mixed with more or less quercitron bark, sumac and hypernic wood, together with a small quantity of chalk. This dyeing operation is carried on in a large vat filled with water, which is gradually heated nearly or quite to the boiling point, the cloth being kept constantly moved in the dyeing liquid. The dyeing with madder and the preparations of madder requires more care than the dyeing with most other stuffs, on account of the peculiar nature of the coloring principles contained in madder and its preparations. After dyeing, the cloth is washed, and then it is very commonly passed for some time through a hot mixture of bran and water. It is then washed, and is passed first through hot water, then through a weak solution of chloride of lime, then through water again, then it is passed through starch paste, to which a little ultramarine, or extract of indigo, has been added. It is then dried, sprinkled, calendered and folded. In the case of madder pinks the dyeing is effected with a large quantity of madder, and the cloth is subsequently boiled for some hours in a strong solution of soap. It is then washed, passed through a solution of per chloride of tin, washed, and again boiled with soap. In this way a great excess of color is first imparted to the cloth, and the dull part of that color is removed by the soaping.

699 The artificial alizarine may be, and sometimes is, used for dyeing in the same way as the preparations of madder, but it is more commonly used for steam colors, the steam colors being more easily produced, and requiring less time for the production of the finished prints. In the steam style the color and mordant are mixed with a suitable quantity of water. The mixture is thickened with starch or gum. It is then printed on cloth. The cloth is then dried, and, without waiting for aging, it is hung for thirty minutes or more in a tight chest, to which dry steam at a temperature of about 216° Fahrenheit is admitted. In order to produce an evenness in the colors from end to end of the pieces the cloth is then folded over end for end, and hung again in the steaming box for thirty minutes or more. It is then washed, starched, calendered and folded. The whole of these operations may be carried out in a single day, and the colors produced by artificial alizarine in this steam style are about as fast as the colors produced in the old madder style, which required a week or more, and a great deal of space.

Q. Could madder, garancine, commercial alizarine and the like be

used in place of artificial alizarine in the steam style or rapid method which you have just described?

A. Madder contains but about one and a half per cent. of useful coloring matter; garancine and commercial alizarine not more than five per cent. of coloring matter; so that it is unpractical to use these materials as such, and the coloring matter is so very slightly soluble in water that we cannot, in the case of madder, as in the case of quercitron bark, log wood, hypernic wood, yellow berries, cochineal, etc., make an aqueous decoction and boil it down to a suitable strength for producing the colors on the cloth. Extracts of madder have, however, been made by resorting to various other solvents, such as an alkaline liquid or alcohol; but these madder extracts contain various impurities which interfere more or less with the successful production of the color, and their cost has been such as to preclude any more than a sparing use of them, and there are some practical difficulties in the way of printing with color made with madder extract, which difficulties are not experienced with the artificial alizarines. Moreover, the cost of artificial alizarine is now such that we can afford to use it for the steam style just as well as garancine for the madder style.

Q. 18. As a practical matter, then, you consider that the general employment of the steam style or rapid method of printing depends upon the existence and supply of artificial alizarine; am I right?

A: You are.

Q. 19. Has the introduction of artificial alizarine effected any economy or improvement in what is known as "piece dyeing" for turkey red?

A. The proper dyeing of turkey red with madder and a mordant of fatty matter was a very long and troublesome operation; but now, by the help of artificial alizarine, it is possible to produce by padding and steaming a very good substitute for the old turkey red,
700 and I know of no way in which so good a substitute for turkey dyed red cloth could be produced before the introduction of artificial alizarine. By padding I mean impregnating the cloth throughout with the color mixture which is ordinarily used for topical printing, a plain roller being substituted for a roller on which figures have been engraved.

Q. 20. Can any preparation from madder root, such as the "flowers of madder," "garancine," "madder extracts," "green alizarine," "commercial alizarine," or the like, be with any propriety called "artificial alizarine"?

A. I do not consider that they can. Chemists usually understand by the term artificial dyestuffs those which are produced from none of the dyes contained in plants or animals, nor from the glucosides of those principles.

Q. 21. Do Graebe and Liebermann claim or describe in their patent that their dyestuff prepared from anthracine, called artificial alizarine, is identical with the alizarine from madder root?

A. They do not; they simply say that it may be used in the same manner as the different preparations from madder.

Q. 22. Was chemically pure alizarine ever used as a dye-stuff?

A. I have never known it to be so used, nor have I ever read or heard of its being so used.

Q. 23. What do you understand by the statement you have just quoted from the patent, Exhibit A, to the effect that the alizarine there described "can be employed in the same manner as the different preparations from madder"?

A. I understand that the artificial alizarine may be used for dyeing and for steam work and as an efficient substitute for madder or the preparations of madder.

Q. 24. How are the various madder preparations known prior to the patent Exhibit A, described among those using them and dealing in them?

A. They were generally spoken of in reference to their method of preparations and the uses to which they may be put, and sometimes are spoken of as being so much stronger and so much weaker than madder. Thus garancine was spoken of as being about three times as strong as madder and not injuring the whites in dyeing, and alizarine, that is commercial alizarine or pinkoffin, was spoken of as being particularly adapted to dyeing bright purples.

Q. 25. Having in view the state of the art at the time of the grant to Graebe and Liebermann of their patent, Exhibit A, and of their original patent, do you regard their description therein of their product as correct?

A. I do. They simply describe their product as consisting of yellow flocks, without stating what particular principles or ingredients those flocks contained. In fact, the state of science was such
701 at that time that it was impossible to state precisely what the product was in a chemical point of view, nor can it be said that the state of chemical science is such at the present moment that we know exactly what artificial alizarine is; all we can be justified in saying at present is that it is a mixture of substances capable of replacing madder as a dye-stuff, but that it contains some substances which are not found in madder and which yet contribute in a great degree to the production of fast colors.

Q. 26. When the term "pure" is used in the arts as in the statement that a substance is so pure that it can be used for a certain purpose, is this understood to mean chemically pure, or in what sense is the word employed?

A. It seldom means absolutely pure, but is usually understood to imply that the substance is free from foreign matters which might in some case prove injurious for the uses to which it is to be applied. Thus I have made and sold a great many hundred of carboys of pure nitric acid which was marked and sold as pure nitric acid. By this was meant not that the nitric acid was absolutely free from iron, or alumina, or nitrous acid, or ammonia, or potash, or soda, or lead, but that it was so far pure from chlorine that it was suitable for dis-

solving silver, one of the chief uses to which nitric acid is put. We distinguish in commerce and the arts substances as being crude, as being adulterated, as being pure, and as being absolutely or chemically pure.

A dye-stuff may be said to be pure when it contains nothing which is liable to injure the tint which the dyer desires to produce, and yet the coloring matter itself may be made up of several distinct chemical substances, each of which contributes to produce the desired effect.

Q. 27. Have you read the various descriptions of processes for the manufacture of artificial alizarine which have been published subsequently to Graebe and Liebermann's original patent, and if so, what do you understand to be their resemblance to, or difference from, the process described in said patent of Graebe and Liebermann?

A. I have examined these different processes, and I consider them to be essentially the same. The process described by Graebe and Liebermann depends, in the first place, upon the conversion of anthracene into anthrachinone, which is simply a process of oxidation, and it is immaterial whether this oxidation is performed by means of chromic acid, or peroxide of manganese, or nitric acid, or bromine, or chlorine, or chlorate of potash, or nitrate of potash. The anthrachinone is then combined with what is denominated in chemistry a radical, and it is immaterial whether this is chlorine, or bromine, or nitryl, or sulphuryl.

It simply requires that there should be something in chemical combination with the anthrachinone which may afterwards be replaced by hydroxyl, and which may be withdrawn from the combination by itself combining with the hydrogen of the hydrate
702 of potassium or of sodium. In the original specification this radical is bromine or chlorine. In the subsequent so called improvements the radical to be replaced is sulphuryl or nitryl. The principle involved is the same in all cases, and any chemist who had found that bromine would answer the purpose would naturally be led to suppose that chlorine, or iodine, or $N O_2$ or $S O_2$ might be made to replace the bromine in bibromanthrachinone. It matters little whether the first two steps succeed each other in the order which I have named or in any other order. The formation of anthrachinone, or any equivalent, and the formation of bibromanthrachinone, or any equivalent, and the subsequent decomposition of bibromanthrachinone, or its equivalent, by hydrate of potassium, or of sodium, are the essential steps of the process.

The starting point in all cases is the same, namely, anthracene; the intermediate products are to all intents and purposes the same; the final operation is the same; and the final product, artificial alizarine, is the same.

Q. 28. What, if any, analogy do you find between the process by which artificial alizarine was produced by Graebe and Liebermann

and that by which madder alizarine is formed in the root of the madder plant?

A. I see no analogy whatever. In the first place the madder alizarine, like all other vegetable substances, is produced from the carbonic acid of the air and from water by a process involving the action of life, directing the chemical agency of sunlight, and this process is mainly one of deoxidation, for vegetable substances all contain a less relative amount of oxygen than the carbonic acid from which they are formed. This action goes on at the ordinary temperature of the air, and without the assistance of any of the powerful chemicals which we use in the laboratory. On the other hand, artificial alizarine is produced from anthracene, which is itself a product of the decomposition of coal at a bright red heat, and anthracene is not known to occur at all in the vegetable kingdom. This anthracene which contains no oxygen at all requires for its change into anthrachinone the most powerful oxidizing agents which are at the command of the chemist, and the chemical agents which are used would disintegrate and destroy any ordinary vegetable matter. The chemical agents which are combined with the anthrachinone in one of the steps of the manufacture of artificial alizarine are of a powerfully corrosive nature, and the heat which is used in all these steps is far above the boiling point of water, and the heat so used is of such long continuance that any but the most stable bodies would be destroyed by it.

Adjourned.

703 *Dec. 5th*, 1876.

Q. 29. You say in answer to int. 12, speaking of the specimens of artificial alizarine, named in your answer to int. 9, that some are a little thicker than others. Which specimens are thicker than others?

A. The specimen "Artificial Alizarine Exhibit Browne 1" was thicker than any of the others, as it had evidently lost some of its original water by evaporation. The specimen marked "Artificial Alizarine V D" was next in point of thickness. The specimen marked "Artificial Alizarine D" was somewhat thinner than either of those just mentioned, and the specimen of commercial artificial alizarine which I had on hand was still thinner. The specimen made by Carl Pickhardt himself had not been refined and brought to the state of paste, but was still in the form of a very thin liquid.

Q. 30. Was you able to discover any other difference in quality between those several specimens of artificial alizarine besides what you have mentioned in your last answer?

A. There was a very slight difference in respect to the goodness of the tints produced. That which was made by Carl Pickhardt appeared on a second test the best of all. Between the specimens marked "Exhibit Browne 1" and "Artificial Alizarine V D," it was difficult to choose. The specimen marked "Artificial Alizarine D" was not fully equal to that marked V D, and the specimen I had on

hand was not quite equal to the others in the goodness of the tints produced. It would be fair to say that the first three named were to all intents and purposes the same.

Q. If you have made any swatches or dyeing tests with artificial alizarine and with preparations of madder for the purpose of ascertaining the merits of these articles of dyestuffs, please produce them to be used as exhibits in this case, and describe what they are.

A. I have here swatches which I have dyed with the artificial alizarine marked "V D," the artificial alizarine marked "Exhibit Brown 1," the artificial alizarine made by Mr. Carl Pickhardt according to the original bromine process, and an artificial alizarine which I had on hand before receiving those specimens from Mr. Carl Pickhardt. I have also here swatches which I have dyed with garancine V C, with flowers of madder, with Meissonier's extract of madder, and with Hunter's extract of madder. One set of these swatches has been simply washed with water; one set has been boiled for some time with soap; and a third set, after being boiled with soap and dried, has been padded with a thickened solution of red prussiate of potash, dried, heated with a solution of caussic soda, then with boiling water, and then boiled with soap. The effect of this latter treatment is such as to show a very marked difference in the fastness of the colors produced by artificial alizarine and those produced by the preparation of madder.

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The specimens marked "pb," "pb^{1}," and "pb^{11}" have been produced with Mr. Carl Pickhardt's artificial alizarine.

The specimens marked "g," "g^{1}," and "g^{11}" have been dyed with the artificial alizarine V D.

The specimens marked "d," "d^{1}," and "d^{11}" were dyed with some of artificial alizarine marked "Exhibit Browne 1."

The specimens marked "10," "10^{1}," and "10^{11}" were dyed with the artificial alizarine which I had on hand.

The specimens marked "m," "m^{1}," and "m^{11}" were dyed with garancine V C.

The specimens marked "7," "7^{1}," and "7^{11}" were dyed with the flowers of madder.

The specimens marked "6," "6^{1}," and "6^{11}" were dyed with Hunter's extract of madder.

The specimens marked "f," "f^{1}," and "f^{11}" were dyed with Meissonier's extract of madder.

The exhibits I will mount on cards for convenience of reference, and I will give on the margin of the cards such a designation as will identify the several exhibits.

(Counsel for complainants offers in evidence the several exhibits produced and referred to in the last answer.)

Q 32. Was you present and did you hear the witness, James Harley, give his testimony in this case in answer to int. 35, and do you know the exhibits he referred to?

A. I was here and arranged the exhibits for his inspection, to which he referred in that answer, without giving him any intima-

tion as to the specific dyestuffs which were used in making them, and these exhibits are the same as those marked by the same letters among the exhibits which I have just produced.

Q. 33. Did you yourself dye the eight swatches which are referred to in int. 35 and the answer thereto, in said Harley's testimony?

A. I did dye those swatches and prepared them with the materials and by the methods which I have described in answer to int. 31, where I referred to them. I dyed all the swatches named in my answer to int. 31.

Q. 34. In a previous answer you have stated that the cloth dyed with madder and with commercial preparations of madder did not show as fast colors as that dyed with artificial alizarine; are you able to assign any reason for this difference, or to what do you
705 attribute it?

A. I should consider this difference as indicating that the mixture of coloring matters contained in artificial alizarine is different in its character from the mixture of coloring matters contained in madder and the preparations of madder.

Q. 35. Is there anything among the exhibits which you have produced which illustrates this difference in character?

A. One out of each series of those exhibits has been treated with ferricynide of potassium, which is a powerful oxidizing agent and is calculated to destroy all such colors as are not very fast; and the effect of this oxidizing or bleaching treatment on colors dyed with the preparations of madder is very decided, while the effect on the colors produced by the artificial alizarines is very slight and but little detrimental.

Q. 36. Have you read the testimony thus far given in this suit by Prof. Henry Morton, and if you have, please state whether or not you agree with what he stated in his testimony on the questions of the novelty and usefulness of the product "artificial alizarine," described and claimed in complainants' patent No. 4321, Exhibit A, in this case?

A. I have examined the testimony thus far given by Prof. Morton, and consider the replies given by him respecting the novelty and usefulness of Graebe and Liebermann's invention to be perfectly correct.

Q. 37. Please state also whether or not you agree with Prof. Morton in what he has stated in his said testimony as to the non-identity of artificial alizarine with madder or any of the preparations of madder?

A. I do agree fully with him, and I believe the testimony which he has given is fully borne out by the literature of the subject. As far as I can learn, it is the universal belief of scientific men that the discovery of artificial alizarine is due solely to Messrs. Graebe and Liebermann, and it seems to be still a matter of doubt among scientific men as to whether any of the substances contained in artificial alizarine are fully identical with any of the substances contained in

madder; and I believe it to be well established that there are several important substances contained in artificial alizarine which have never been found in madder or its preparations and are never likely to be found in them.

[Cross-examination of this witness is reserved.]

JOHN M. ORDWAY.

Attest: JOHN G. STETSON,
Examiner.

706 BADISCHE ANILIN AND SODA FABRIK
vs.
A. COCHRANE et al.

NEW YORK, *Jan.* 3*d*, 1877.

Present—J. Van Santvoord, esq., for compl'ts; E. N. Dickerson, esq., for def'ts.

Continuation of the examination of Prof. ORDWAY:

Q. 38. On what day did you receive the package from Mr. Carl Pickhardt, to which you refer in your answer 9?

A. I received the package by express from Carl Pickhardt November 21st, 1876. The articles were contained in a box, which was tied up, and the string was sealed with a seal which proved to be identical with one sent on by mail by Carl Pickhardt.

JOHN M. ORDWAY.

Attest:—JOHN G. STETSON, *Examiner.*

707 BADISCHE ANILIN AND SODA FABRIK
vs.
JAMES HIGGIN, ABRAHAM LLOYD, JOHN O'ROURKE AND JOHN SIMPSON.
In Equity.

NEW YORK, *Jan'y* 24, 1876.

Present—J. Van Santvoord, esq., sol'r for compl'ts; G. M. Plympton, esq., sol'r for def'ts.

Cross-examination of Prof. ORDWAY, by G. M. Plympton, esq.:

Prof. John M. Ordway, in answer to cross-interrogatories proposed to him by G. M. Plympton, esq., counsel for defendants, saith:

x-q. 1. Did you ever try to dye with madder or its preparations by what is known as the "steaming process?"

A. I have had no practical experience in the use of madder extract for steam colors, because the extract of madder came into common use after I left the Manchester Print Works.

x-q. 2. Did you ever dye, experimentally or otherwise, with pure alizarine from madder?

A. I have made one or two experiments with chemically pure ali-

zarine, but have not had sufficient to make an extensive series of experiments.

x-q. 3. Will your same answer apply to chemically pure alizarine prepared from anthracene?

A. It will not, for I have never prepared or caused to be prepared any pure alizarine made from the so-called artificial alizarine.

x-q. 4. If your experiments with pure alizarine from madder and pure alizarine from anthracene have been in the direction of ascertaining their identity, state, if you please, the result arrived at by you from such experiments?

A. I have made no experiments which would enable me to give decided testimony respecting the absolute identity of the two pure alizarines.

x-q. 5. Purpurine is derived from madder or its extracts. If you have dyed with purpurine state what color you obtained.

A. I have never dyed with pure purpurine, but those preparations of madder which contain a considerable amount of this substance give good reds and very poor purples, whereas those which contain a large amount of alizarine give good purples and poor reds. In order to produce the shades which are desired on calicos we generally want a mixture of alizarine and purpurine, or an equivalent to purpurine, such as anthra purpurine.

708 x-q. 6. When you speak of a mixture of alizarine with purpurine, what do you mean by alizarine?

A. I mean what has generally been considered the more important principle in madder and which is probably an alizarine, but whether it is precisely the same as sublimed alizarine I am by no means certain.

x-q. 7. Have you any dyed exhibits in the nature of swatches? If yes, will you please produce them?

A. I have here four cards of swatches which I have dyed.

(Complainants' counsel introduces the four cards of swatches produced by the witness and they are put in evidence and marked:

"Complainants' Exhibit, Ordway No. 1, J. G. S., exam'r, Jan. 24, 1877."

"Complainants' Exhibit, Ordway No. 2, J. G. S., exam'r, Jan. 24, 1877."

"Complainants' Exhibit, Ordway No. 3, J. G. S., exam'r, Jan. 24, 1877."

"Complainants' Exhibit, Ordway No. 4, J. G. S., exam'r, Jan. 24, 1877.")

x-q. 8. Please state what those exhibits represent.

A. The exhibit marked "Ordway No. 1" contains:

swatches marked "6," "6^{1}," "6^{11}"—"f," "f^{1}," "f^{11},"

of these "6," "6^{1}" and "6^{11}" were dyed with Hunter's extract of madder;

the one marked "6" was simply dyed and washed with water.

"6^{1}" was dyed, then boiled for 15 minutes in a solution of soap;

then boiled again 10 minutes in a solution of soap and then washed with water;

the one marked "6^{II}" was prepared in the same way as "6^{I}," being in fact part of the same piece; it was then after drying padded with a solution of red prussiate of potash and dried; then it was treated for some minutes with a cold solution of caustic soda at 10° B., then boiled in water for about 10 minutes, then washed and dried. The object of this latter treatment was to imitate as far as possible the effects produced on ordinary calico clothing by long continued use and frequent washings.

In the same exhibit "Ordway No. 1,"

the swatches marked "f," "f^{I}" and "f^{II}" were prepared in the same way respectively as "6," "6^{I}" and "6^{II}"; Meissonier's extract of madder being used in place of Hunter's extract.

In the exhibit marked "Ordway No. 2,"

the swatches marked "7," "7^{I}" and "7^{II}" were treated in the same way respectively as "6," "6^{I}" and "6^{II}"; flowers of madder being used in place of Hunter's extract.

In the same exhibit "Ordway No. 2,"

the swatches marked "m," "m^{I}" and "m^{II}" were treated in the same way respectively as "6," "6^{I}" and "6^{II}"; the commercial garancine of the brand V C being used in place of Hunter's extract of madder.

709 In the exhibit marked "Ordway No. 3."

the swatches marked "pb" "pb^{I}," "pb^{II}" were treated in the same way respectively as "6," "6^{I}" and "6^{II}," there being used in place of Hunter's extract of madder a sample of artificial alizazine prepared by Mr. Carl Pickhardt according to the original receipt (recipe) of Graebe and Liebermann, that is with bibrom-anthrachinone;

the swatches marked "10," "10^{I}" and "10^{II}" were prepared in the same way respectively as "6," "6^{I}" and "6^{II}"; there being substituted for Hunter's extract a sample of artificial alizarine for purple found in commerce three or four years ago.

In exhibit marked "Ordway No. 4,"

the swatches marked "g," "g^{I}" and "g^{II}" were prepared in the same way respectively as "6," "6^{I}" and "6^{II}"; the complainants' artificial alizarine V D being used in place of Hunter's extract;

the swatches marked "λ," "λ^{I}" and "λ^{II}" were prepared in the same way respectively as "6," "6^{I}" and "6^{II}"; there being used in place of Hunter's extract some of the artificial alizarine already in evidence and marked "Complainants' Exhibit D."

These exhibits correspond throughout with a set already introduced in the suit of Badische Aniline and Soda Fabrik *vs.* A. Cochrane, Hugh Cochrane and Carl Rumpff, with the exception of the exhibits "λ," "λ^{I}" and "λ^{II}," which are here put in, in place of those marked "d," "d^{I}" "d^{II}," which were dyed with the artificial alizarine marked "Exhibit Browne 1."

The artificial alizarine above mentioned as being made by Mr.

Carl Pickhardt is some which was sent to me by him, and is referred to in my answers 9, 31 and 38 in my testimony originally taken in the suit of these complainants against A. Cochrane and others.

x-q. 9. State from what source you procured the material with which you dyed exhibit "Ordway No. 1;" also exhibit "Ordway No. 2;" also exhibit "Ordway No. 3," and also exhibit "Ordway No. 4."

A. All the exhibits, with the exception of swatches marked "6," "6^{I}" and "6^{II}," and "10," "10^{I}" and "10^{II}," were dyed with specimens sent me by Mr. Carl Pickhardt. The Hunter's extract of madder and the artificial alizarine used to dye swatches "10," "10^{I}" and "10^{II}" were taken from specimens belonging to the collection of dyestuffs in the Massachusetts Institute of Technology.

x-q. 10. That is, if I understand you rightly, the material with which exhibit "Ordway No. 1" was dyed, so far as specimens "6," "6^{I}" and "6^{II}" are concerned, came from the Technological Institute, and all the specimens on exhibit "Ordway No. 2" were dyed with material obtained from Mr. Carl Pickhardt; am I right?

A. You are.

710 x-q. 11. Please state if the specimens "6," "6^{I}" and "6^{II}," on exhibit "Ordway No. 1," and "7," "7^{I}" and "7^{II}," on exhibit "Ordway No. 2," were designed to represent corresponding colors, shades or tints?

A. All the swatches you have referred to in your question were mordanted alike; that is, they were taken from the same piece of cloth which had been printed with the different mordants and made ready for dyeing, and were intended to show the same hues and the same shades of colors; in other words, the specimens "6," "6^{I}" and "6^{II}" of "Ordway No. 1," and the specimens "7," "7^{I}" and "7^{II}" of "Ordway No. 2," are parts of the same piece of cloth, which was mordanted for the purpose of making comparative tests at the same time and with the same mordants.

x-q. 12. What is the difference between Hunter's extract of madder and flowers of madder, as you understand it, or as it is understood by calico printers?

A. Hunter's extract of madder is a paste containing the coloring matter of madder without the woody matter of the roots. It has been used more particularly for steam colors. The flowers of madder were formerly made by subjecting the ground madder roots to fermentation and subsequent washing, whereby the sugar and starch of the madder roots were removed while the woody fibre and the coloring matters remained unchanged, or but slightly changed; as the flowers of madder consist in great part of matters which form no office in dyeing, they cannot well be used for steam colors, and, therefore, have been used only in dyeing. The coloring principles should be the same in both.

x-q. 13. Is the presence of anthrapurpurine in the so-called artificial alizarine the thing that chiefly distinguishes the artificial alizarine from madder alizarine?

A. The presence of anthrapurpurine and other substances which have not as yet been fully investigated have much to do with the application of artificial alizarine in printing. Anthrapurpurine and several other substances which are contained in artificial alizarine are not contained in madder. The usefulness of either madder or artificial alizarine depends for some purposes mainly on the alizarine portion, and for other purposes mainly on the purpurine portion. As far as my experiments have gone, they go to show that the mixture of madder alizarine and purpurine that exists in madder, is not so fast as the mixture of anthracene alizarine and anthrapurpurine which is contained in artificial alizarine, and I do not think that any one would be justified in saying either that anthrapurpurine is or is not the thing which mainly distinguishes artificial alizarine from the coloring matter that exists in madder. Our knowledge is as yet too imperfect to enable any one justly to make a decided statement upon that point.

711 x-q. 14. So far as your knowledge extends, as a chemist, as a practical dyer, and as an experimenter for the purpose of this suit, as between madder alizarine and the artificial alizarine, can you not say that anthrapurpurine is the chief element of difference between the two kinds of alizarine, saying nothing of the substances, the specific values of which and their constituents, you say, are yet undetermined?

A. I cannot.

x-q. 15. Can you say what are the chief elements of difference between the two kinds of alizarine?

A. I cannot tell what the chief elements of difference are; I only know that different effects are produced in dyeing; why those differences are produced I cannot tell.

x-q. 16. Can you get from artificial alizarine colors that cannot be produced from madder or its preparations; and when I say colors I mean colors in their broadest sense, and not mere gradations of shade?

A. I think colors may be produced by means of artificial alizarine which cannot be produced with madder or the ordinary preparations of madder without resorting to treatment which is impracticable on account of the expense involved. Whether these colors can in any way be produced from the preparations of madder, I am not prepared to say.

x-q. 17. Then, if I understand your answer correctly to the last cross-question, it is in substance that from your own knowledge you cannot answer it affirmatively or negatively; am I correct?

A. You are.

x-q. 18. About what percentage of fibrous matter or cellular tissue is found in the madder dyes of commerce?

A. In madder about 30 per cent. consists of cellulose or woody fibre, the rest being starch, sugar, gum, pectin and coloring matter. The coloring matter amounts to about one per cent. In garancine, from which the starch and sugar have been eliminated, the woody

fibre and pectin make up at least 90 per cent. In flowers of madder the woody fibre and pectin probably make up at least 75 per cent.; the extract of madder contains no woody fibre.

x-q. 19. The woody fibre removed, leaves the alizarine purer and better for dyeing, does it not?

A. I certainly does.

x-q. 20. What is the value of pectin, and what its characteristic?

A. Pectin is a substance which is insoluble in water and acid solutions, but it is capable of undergoing modifications through the influence of heat, and one of its modifications constitutes the gelatinizing principle of the fruit jellies, such as cranberry jelly. The pectin has very little influence in dyeing, but it is probable that one of its modifications enters to some extent into the composition of extract of madder, and so far decreases the utility of the madder extract.

712 x-q. 21. Pectin removed, alizarine from madder is improved for dyeing purposes, is it not?

A. It is.

x-q. 22. Did you ever dye with alizarine from madder, having removed from it cellulose and pectin?

A. I cannot say that I have, except so far as I have made experiments with Kopp's purpurine and Kopp's green alizarine, which contains no cellulose; but whether they are entirely free from any modification of pectin I do not know.

x-q. 23. What is Kopp's madder preparation, and is it free from any of the impurities you have named, such as wood and pectin?

A. Kopp's preparations are made by treating madder with a solution of sulphurous acid, and are obtained from the part which is soluble in such solution. Of course the woody fibre, and the larger part of the pectin, and a considerable part of the starch, are left undissolved, and therefore do not enter into the composition of purpurine or of green alizarine.

x-q. 24. Are you the Prof. John M. Ordway who was sworn and heretofore testified in the case of these complainants against A. Cochrane and others on December 4, 1876?

A. I am.

JOHN M. ORDWAY.

NEW YORK, *Febr'y* 12, 1877.

Counsel present as before.

Continuation of the examination of Prof. JOHN M. ORDWAY:

Red. q. 25. What do you mean by the expression "an equivulent to purpurine, such as anthrapurpurine," in your answer to cross-question 5?

(Objected to by counsel for def'ts on the ground that the witness's meaning is clearly expressed in the answer referred to, and on the further ground that it is a leading question.)

A. The idea which I intended to convey by the expression "an

equivalent to purpurine" was that of a substance or mixture of substances which would produce about the same shades of color, and not that of chemical equivalency or identity.

Re-d. q. 26. Is there any other substance besides anthrapurpurine which can be classed among the substances or mixture of substances to which you allude, and which would produce about the same shades of color?

(Objected to as leading.)

713 A. Isopurpurine, as well as anthrapurpurine, is known to produce, with iron and alumina mordants, shades similar to those produced by madder purpurine and its modifications, such as purpurine hydrate.

Re-d. q. 27. In what sense do you use the word "receipt" in folio 611, in your answer to cross-question 8?

(Objected to, as the sense in which the word is used is apparent in the answer.)

A. I have used the word "receipt" to express the same meaning as is often expressed by the word recipe—that is, to indicate the method and the proportions used in the manufacture of any particular compound.

Re-d. q. 28. To what artificial alizarine do you allude in the expression in the same folio, in your answer cross 8, where you say "a sample of artificial alizarine for purple found in commerce three or four years ago," and state where you obtained the same?

A. I mean the same sample which has been more particularly explained in the last clause of my answer to cross-question 9. The sample was one of a collection of samples of dyeing materials which I have obtained from various dealers for the Massachusetts Institute of Technology.

Re-d. q. 29. In your answer to cross-question 13 you say: "The usefulness of either madder or artificial alizarine depends for some purposes mainly on the alizarine portion, and for other purposes mainly on the purpurine portion." To what do you refer by the words "purpurine portion," in speaking of artificial alizarine, in that sentence?

A. I use the term purpurine here in a generic sense, to express both those portions of madder and those portions of artificial alizarine which go to make the red shades on calico, and, as far as artificial alizarine is concerned, the purpurine portion includes anthrapurpuriue, isopurpurine, and probably other substances which have not been fully investigated.

Re-d. 30. You speak in the next sentence of experiments as to fastness. State what you mean in the comparison you there make by the expression "mixture of anthracene, alizarine, and anthrapurpurine"

(Objected to by def'ts' counsel.)

A. In dictating this sentence I omitted some words in that answer which were needed to make it correspond with the first clause of the first sentence of the same answer. I should have said "an-

thracene, alizarene, anthrapurpurine, and other substances which are contained in artificial alizarine."

714 Re-d. q. 31. Do you wish to correct the sentence of your answer enquired of in the last preceding question by changing it as indicated by you in the last preceding answer?

(Objected to as leading and suggestive and improper. Counsel for the complainants is requested to let the witness testify or take the stand himself.)

A. I should like to make this change, because it would more clearly express what I had in mind in giving the answer to cross-question 13, as the context shows.

Cross-examined by Mr. Plympton:

Re-x-q. 32. Did the counsel for the complainants, or Mr. Pickhardt, the owner or agent for the owners of the patent on which this suit is brought, at any time call your attention to the word "equivalent," and suggest that you change it; if so, where and under what circumstances?

A. Mr. Pickhardt did not send the proof-sheet to me, but brought it to Boston himself, and placed it in my hands in the office of his firm in Boston on the 3d of the present month; before I had time to read it fully he called my attention to the word equivalent, and asked me whether I intended to use the word in the legal sense or otherwise. I told him that I had no idea of using it in the legal sense, and if it was capable of being misunderstood, as it certainly was, I should like to substitute another expression in the corrected copy. I had some conversation with Mr. Pickhardt respecting other portions of the testimony, and sent a note to the counsel for the complainant, requesting him to make a few verbal changes in the testimony. I had had no other conversation respecting the matter, either with Mr. Pickhardt or with complainants' counsel.

Re-x-q. 33. Who suggested writing the note you speak of?

A. Mr. Pickhardt.

Re-x-q. 34. What do you understand to be the legal sense of the word "equivalent?"

A. I understand it to mean the exact substitute—something which will answer in every respect the same purpose.

Re-x-q. 35 Will you say that a mixture of alizarine and purpurine is not an exact substitute for anthrapurpurine to produce given shades on calicos, and that you make your answer to this question from your practical experience as superintendent of a dye-house?

A. I do say that they are not equivalents, but I do not base my answer altogether on practical experience in the dye-house, as I have had no direct connection with print works since the introduction of artificial alizarine.

715 Re-x-q. 36. Then, if I understand your answer correctly, you have no practical knowledge as to whether a mixture of alizarine and purpurine is or is not an exact substitute for anthrapurpurine; am I correct?

A. I have some practical knowledge, though I have not made experiments with artificial alizarine on a large scale; laboratory experiments suffice to give one an idea of the relative value of different dye-stuffs.

Re-x-q. 37. State in detail what experiments you made in your laboratory that enables you to swear positively that a mixture of alizarine and purpurine is not an exact substitute of anthrapurpurine.

A. I have already detailed some of the experiments, and put in as exhibits illustrative specimens which show that when pieces of the same mordanted cloth are dyed with substances containing madder alizarine and the madder purpurines, and with artificial alizarine, the colors produced are not precisely the same, and with respect to fastness they are very different. I have not, however, isolated anthrapurpurine to compare it by itself with the colors produced by a mixture of madder alizarine and madder purpurine.

Re-x-q. 38. Then, so far as whether anthrapurpurine, without an admixture with other substances, is an exact substitute for a mixture of alizarine and purpurine you cannot state; am I correct?

A. You are not correct. I cannot state it from direct experimental knowledge, but a paper has been published in the Journal of the Chemical Society, which is illustrated by swatches, showing how anthrapurpurine acts by itself.

Re-x-q. 39. Is this paper the only source of knowledge you have concerning the matter enquired of in the last cross-question?

A. This is the only paper which gives ocular demonstrations, but there are other papers which speak of it. It is not the only source of my knowledge on this point; there are some other papers which I cannot name without looking back to the various papers I have read.

Re-x-q. 40. Of your own practical knowledge, however, you cannot swear that anthrapurpurine is an exact substitute for a mixture of alizarine and purpurine, can you; nor can you swear to the contrary, can you?

A. I cannot.

Re-x-q. 41. Please give me the title and the author of the paper you refer to in your answer to the 38th cross-question as being published in the Journal of the Chemical Society?

A. As I have not the volume at hand I cannot give the exact date nor title of the paper, but I think it was written by Schunck. I can, however, if it is desired, give the date and title after my return home.

(The witness is requested to do this by letter to def'ts' counsel.)

716 Re-direct by J. Van Santvoord:

Re-d. q. 42. Look at the letter I now show you, and state whether or not that is the note you speak of in answer to cross-question 32, as having been sent by you to compl'ts' counsel?

A. It is.

(Counsel for compl'ts offers in evidence the note referred to, and the same is marked "Compl'ts' Exhibit Ordway letter, J. G. S. examiner, Feb'ry 12, 1877.")

JOHN M. ORDWAY.

Attest: JOHN G. STETSON,
Examiner.

Compl'ts Exhibit Ordway Letter.—J. G. S., examiner, Feb'y 12, 1877.

BOSTON, *Feb. 3d*, 1877.

J. VAN SANTVOORD, esq.:

DEAR SIR: In reading over my testimony, as put in type, I notice one or two places in which the language is not quite as precise as I wish to have it. In answer to x-int. 5, in the last sentence, I should like to put instead of—

"An equivalent to" the expression "substitutes for."

I should like also to make the meaning more complete by adding at the end of the sentence "and isopurpurine."

I find that, in the answer to x-int. 8, I have not given the same designation to one sample of artificial alizarine that I have used in another part of the testimony. So in the clause commencing

"The swatches marked 10," I would strike out "for purple," and insert in its place

"From the collection of the Massachusetts Institute of Technology."

In the answer to x int. 13, the third sentence should read:

"The usefulness of madder alizarine depends for some," &c.

And to make the 4th sentence agree with the 1st sentence, I should say:

"As far as * * * * * * * * so fast as the mixture of anthracene alizarine with anthrapurpurine and the other substances which are contained in artificial alizarine," &c.

Please have these changes made in the printed copy, and oblige

Yours truly,

JOHN M. ORDWAY.

MASS. INST. TECHNOLOGY,
Feb'ry 17th, 1877.

G. M. PLYMPTON, esq.:

DEAR SIR: The paper to which I referred as being accompanied with swatches dyed with alizarine and anthrapurpurine is one

"On anthrapurpurine. By W. H. Perkin, F. R. S."

It was published in the *Journal of the Chemical Society*, of London, in the year 1873, vol. XI, p. 425.

Yours truly, JOHN M. ORDWAY.

717 *Deposition of James Harley.*

Direct examination by J. Van Santvoord, esq., of counsel for complainants.

BOSTON, *Dec.* 5, 1876.

Q. 1. Please state your name, age, residence and occupation.

A. James Harley; 40; Lowell, Mass.; calico printer.

Q. 2. How many years have you been a calico printer, and where, and in what capacity?

A. I have been connected with calico printing for twenty-four years; in Scotland for many years in the capacity of color mixer, in London for several years in the capacity of color mixer and manager of print works, and in the United States with the Hamilton Woolen Company at Globe Village, Mass., for a year and a half as color mixer, and with the Hamilton Manufacturing Company in Lowell, Mass., about nine years as assistant superintendent and color mixer. My connection with the last named company terminated about nine months ago.

Q. 3. Describe briefly your duties as color mixer and as assistant superintendent of the Hamilton Manufacturing Company.

A. My duties as assistant superintendent were to promote the interests of the company, and as color mixer to produce the required effects on calicos in colors.

Q. 4. Please describe more particularly what you mean by the expression "to produce the required effects on calicos in colors." What did you have to do for that purpose?

A. I had to mix the colors to put on the cloth. There were certern patterns shown as designs and colors to go by, and my business was to produce those colors and effects on the cloth. I took the different drugs that I considered best to produce a certain effect, mixed those drugs in the shape of color, and gave them to the printer to put on the cloth, and saw that the proper result was attained.

Q. 5. What styles of calicos did you produce chiefly at the Hamilton Manufacturing Company's works?

A. Madder styles.

Q. 6. What dyestuffs did you chiefly use for producing those madder styles?

A. Madder, garancene, sumac, in different proportions.

Q. 7. What is garancene?

A. A preparation of madder.

Q. 8. Did you use any other dyestuffs besides those you have named for producing madder styles?

A. Yes, sir.

718 Q. 9. What other dyestuffs?

A. Extract of madder and artificial alizarine.

Q. 10. What is extract of madder?

A. Coloring matter derived from madder.

Q. 11. How did you use garancine for producing the madder styles?

A. The mordant or mordants were first printed on the cloth, then aged and passed through silicate of soda, or arseniate of soda, or both. Then the goods were put into a dye beck or bath along with the garancine, and dyed to the required shade.

Q. 12. How did you use madder extract for that purpose?

A. In combination with the mordants as a topical color, then submit it to steam, afterwards soaped.

Q. 13. How did you find the madder extract to work for that purpose?

A. Two difficulties presented themselves; one was grit in the color, and the other that it stuck in the engraving.

Q. 14. Please explain more fully to what you refer by the expression "it stuck in the engraving," and what it is that "stuck in the engraving." Please state fully and particularly to what you refer.

A. The extract of madder filled the engraving, consequently we could not get an impression of the engraving on the cloth. As the component parts of the color are starch, acetic acid and extract of madder, acetate of alumina and acetate of lime, and neither of them except the extract of madder will stick in the engraving of themselves, consequently we came to the conclusion that it is the extract of madder that sticks in the engraving.

In working the color we found that we could only print an amount of pieces that would make it almost impracticable to work it, from the fact that it took the edge off the printers' doctor, and necessitated the stopping of the machine, and consequently we abandoned the use of extract of madder.

Q. 15. How did you use artificial alizarine for this same purpose; and state how that worked?

A. We used it practically in the same way. We never had any difficulty with it whatever.

Q. 16. To what method of calico printing do you here refer?

A. What is known in the print business as topical printing.

Q. 17. Did you also use at the Hamilton Print Works artificial alizarine in dyeing madder styles?

A. Yes, sir.

Q. 18. How did you use it for that purpose?

A. Usually in combination with garancine, sumac, and other dyestuffs, such as Persian berries and flavine, to obtain fine results such as are required on styles known as robe styles.

719 Q. 19. How did you find that artificial alizarine worked for that purpose?

A. We got better results from it in combination with garancine than we could get by garancine alone.

Q. 20. How then in your opinion does artificial alizarine compare with garancine and with madder extract, for producing good results in topical printing and in dyeing calicos; which is superior for those purposes?

A. In my experience I have always got better results from artifi-

cial alizarine than I could get from madder, garancine or extract of madder.

Q. 21. How long have you used artificial alizarine as a dyestuff?

A. I am not prepared to give any date, but since the first introduction of it into this country, say five or six years.

Q. 22. Have you used much of it as a dyestuff while at the Hamilton Print Works?

A. Yes, sir.

Q. 23. Have you found any considerable variation in the quality of the artificial alizarine you have used?

A. We have found a little variation in the quality.

Q. 24. Did this artificial alizarine which you used at the Hamilton Print Works prove pretty uniform in quality?

A. Yes, sir.

Q. 25. From whom was the artificial alizarine obtained which you used at the Hamilton Print Works, if you know?

A. I don't know. I didn't buy the stuff, and was only there to use it.

Q. 26. Did you understand from what different sources the artificial alizarine used by that company was obtained; and if so, what was your understanding as to this matter?

A. While in the employment of the Hamilton Company I have used artificial alizarine designated as Pickhardt & Kuttroff's and artificial alizarine designated as Cochrane's.

Q. 27. How did the a ial alizarine designated as Cochrane's compare in quality with that designated as Pickhardt & Kuttroff's?

A. We found Pickhardt & Kuttroff's to give a little the best result?

Q. 28. State whether or not the use of artificial alizarine as a dyestuff in this country is increasing.

A. In my opinion, it is.

Q. 29. What effect has the introduction of artificial alizarine into use as a dyestuff had upon the use of madder and preparations of madder as dyestuffs?

A. It has diminished the use of them in print works.

Q. 30. What effect has the introduction of artificial alizarine into use as a dyestuff had upon the manufacture of calicos?

720 A. It has enabled printers to produce effects that could not be obtained by the use of garancine or madder.

Q. 31. State whether or not it has enabled printers to improve calicos, and if so, in what respects?

A. Calicos have been improved by the use of artificial alizarine by introducing brighter shades of color, better whites than by the use of garancine or madder, and the work produced more expeditiously.

Q. 32. You have said in answer to interrogatory 18 that you have used artificial alizarine in combination with garancine and other dyestuffs. State whether or not you could have obtained equally good results by using artificial alizarine alone.

A. I could have obtained as good results by using artificial alizarine in place of garancine with other dye-stuffs, such as Persian berries, sumac, and flavine; in fact I could have obtained better results.

Q. 33. Then why did you combine the garancine with the artificial alizarine instead of using the artificial alizarine without the garancine?

A. The price of the artificial alizarine stood in the way of its being generally used, notwithstanding its giving better results.

Q. 34. What is the strength in dyeing properties of artificial alizarine as compared with garancine?

A. From experiments that we have made we have found one pound of artificial alizarine equal to four pounds and a half of commercial garancine.

Q. 34. What brand or quality of garancine was it with which you made this experiment?

A. The brand known in the market as "Lion A." It is considered a good quality.

Q. 35. Will you please examine these eight swatches which have been dyed by Prof. Ordway with different samples of artificial alizarine, and which are marked "g" "d" "pb" "10" "g^1" "d^1" "pb^1" and "10^1," respectively, the last four of which have been soaped, while the first four have only been washed with water, and give your opinion as to the comparative goodness of the shades of color of said swatches?

A. pb^1 is the best, g^1 is very close to it, d^1 is next, and then 10^1. Those which have been washed with water only stand in the same relation to each other, namely, pb, g, d, 10. The three first I have named in each series stand very near to each other.

[The cross-examination of this witness is reserved.]

JAMES HARLEY.

Attest: JOHN G. STETSON,
Examiner.

721 NEW YORK, FRIDAY, *Dec. 8th*, 1876.

Present—John Van Santvoord, esq., counsel for complainant; E. N. Dickerson, esq., counsel for defendants.

JAMES HUNTER, called on the part of the complainant and duly sworn, deposes and says:

Q. 1. What is your name, age, residence, and your profession or occupation?

A. James Hunter; 53 years of age; reside at Philadelphia; and am a calico printer.

Q. 2. How many years have you been a calico printer, and where, and in what capacity?

A. Over 30 years in Philadelphia; I have been engaged in nearly